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The project manager's lieutenant for logistics : a study of the chief logistician's key roles in reducing operation and support costs during developmental programs

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THESIS

THE PROJECT MANAGER'S LIEUTENANT FOR LOGISTICS: A STUDY OF THE CHIEF LOGISTICIAN'S KEY ROLES IN REDUCING OPERATION & SUPPORT COSTS DURING DEVELOPMENTAL PROGRAMS

by

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March 2002

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Extremely high weapon system Operation & Support (O&S) costs have become one of the central issues within the Department of Defense. Historically, O&S Costs represent 60% to 80% of the total life-cycle cost of weapon systems. Consequently, minor increases in O&S Costs across many systems can have major impacts to the efficient execution of the defense budget, restrict the ability to maintain readiness, and deplete funding needed for modernization. The principal finding of this research is that the Chief Logistician of a developmental project office can radically reduce future O&S Costs by fulfilling several key roles during a short time-frame in the system life-cycle. These key roles include a number of strategic imperatives, a half-dozen unique activities related to both the design of the weapon system and the logistics plans for supporting the system, and a full understanding of the techniques to overcome existing inhibitors. Finally, suggestions are presented for over-hauling the Chief Logistician's status in a typical project office to more effectively deal with these difficult challenges of system development.

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ABSTRACT

Extremely high weapon system Operation & Support (O&S) costs have become one of the central issues within the Department of Defense. Historically, O&S Costs represent 60% to 80% of the total life-cycle cost of weapon systems. Consequently, minor increases in O&S Costs across many systems can have major impacts to the efficient execution of the defense budget, restrict the ability to maintain readiness, and deplete funding needed for modernization. The principal finding of this research is that the Chief Logistician of a developmental project office can radically reduce future O&S Costs by fulfilling several key roles during a short time-frame in the system life-cycle. These key roles include a number of strategic imperatives, a half-dozen unique activities related to both the design of the weapon system and the logistics plans for supporting the system, and a full understanding of the techniques to overcome existing inhibitors. Finally, suggestions are presented for over-hauling the Chief Logistician's status in a typical project office to more effectively deal with these difficult challenges of system development.

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ACRONYMS AND ABBREVIATIONS

AAAV	Advanced Amphibious Assault Vehicle
AAN	Army After Next
ACTD	Advanced Concept & Technology Demonstration
AMC	Army Materiel Command
AWACS	Airborne Warning and Control System
BIT	Built-in Test
CAIV	Cost As Independent Variable
CDR	Critical Design Review
COSSI	Commercial Operations & Support Savings Initiative
CPAT	Critical Process Assessment Tools
CPL	Certified Professional Logistician
CROP	Container Roll In-Out Platforms
DIS	Distinctive Interactive Simulation
DCMC	Defense Contract Management Command
DOD	Department of Defense
DSAC	Defense Systems Affordability Council
DTC	Design to Cost
FCV	Future Combat Vehicles
FLIR	Forward Looking Infrared
FSC	Full-Service Contracting
GAO	General Accounting Office
GFE	Government Furnished Equipment
GOCO	Government Owned Contractor Operated
GS	General Schedule
HTI	Horizontal Technology Integration
I^2LS	Industry Integrated Logistics System
IETMs	Integrated Electronic Technical Manuals
ILS	Integrated Logistics Support
IPPD	Integrated Product Process Development
IPT	Integrated Product Team
LCC	Life-Cycle Cost
LORA	Level of Repair Analysis

LRU	Line Replaceable Units
LSA	Logistics Support Analysis
MACOM	Major Command
MLRS	Multiple Launch Rocket System
MOS	Military Occupational Specialty
MTBF	Mean Time Between Failures
MTBMA	Mean Time Between Maintenance Activity
MTS	Modernization Through Spares
MTS	Movement Tracking Systems
MTTR	Mean Time To Repair
MWO	Modification Work Orders
NAVAIR	Naval Air Command
O&M	Operation and Maintenance
O&S	Operation and Support
OPTEMPO	Operation Tempo
ORD	Operational Requirements Document
PDM	Program Depot Maintenance
PEO	Program Executive Office
PLC	Palletized Loading Systems
PM	Program Manager
PMOLCS	Project Manager Oversight of Life-Cycle Support
POL	Petroleum, Oil, Lubricants
PVS	Prime Vendor Support
R-TOC	Reduction of Total Ownership Cost
R&M	Reliability & Maintainability
RCM	Reliability Centered Maintenance
RDT&E	Research, Development, Test, and Evaluation
SOLE	Society of Logistics Engineers
TAV	Total Asset Visibility
TOC	Total Ownership Cost
TSPR	Total System Performance Responsibility
WLMP	Wholesale Logistics Modernization Program

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I. INTRODUCTION

A. PURPOSE

The purpose of this Thesis is to study the reduction in weapon system Operation & Support (O&S) costs from the Project Manager's perspective. Specifically, the Thesis will study the role of the Project Manager's Chief Logistician in reducing O&S Costs during the developmental phase of the life-cycle. Conventional knowledge indicates that approximately 95% of weapon system's O&S Costs are committed by decisions made prior to its Critical Design Review (CDR). Given this major assumption, the objective of this study is to identify and discuss the key roles of the Chief Logistician prior to the CDR, which results in significant reductions to O&S Costs once the system is fielded.

B. BACKGROUND

Excessive weapon system Operation and Support (O&S) costs have become one of the central issues within the Department of Defense (DOD). Historically, O&S Costs represent 60% to 80% of the total life-cycle cost of weapon systems (DSMC ILS Guide, 1999). Consequently, minor increases in O&S Costs across many systems can have major impacts on the execution of the over-all defense budget over extended periods of time. Furthermore, the recent pressure to shift funding from O&S accounts to development & procurement accounts in order to modernize a rapidly-aging inventory of weapons systems have focused intense emphasis on reducing O&S Costs for fielded and future weapon systems.

C. RESEARCH QUESTIONS

1. Primary Research Question: What are the key roles of the Chief Logistician prior to the Critical Design Review (CDR) that result in significant reductions in Operation and Support (O&S) costs once a weapon system is fielded?

2. Secondary Research Questions

a. Prior to the CDR, what are the specific strategic imperatives for significant reductions in future O&S Costs?

b. Prior to the CDR, what are the key "design" activities of the Chief Logistician required to reduce future O&S Costs?

c. Prior to the CDR, what are the key "planning" activities of the Chief Logistician required to reduce future O&S Costs?

d. What are the principal inhibitors that constrain the Chief Logistician in reducing future O&S Costs?

e. What changes can be made to the Chief Logistician's status during developmental programs to enable that person to more effectively reduce future O&S Costs?

D. SCOPE

The scope of this research is an analysis of established acquisition information related to O&S Costs reduction, general initiatives underway to reduce O&S Costs across multiple systems, and major weapon programs across the Department of Defense which have significant O&S Costs. The research has a special focus on the DOD-designated pilot programs for Reduction in Total Ownership Cost (R-TOC). A total of 12 DOD R-TOC pilot programs were studied (four programs for each of the three Services). A cross-section of developmental and fielded weapon systems was selected to balance the analysis between existing and predicted O&S Costs. The research of these weapon systems and general initiatives has been conducted within the general context of established research data about the early genesis of O&S Costs.

E. METHODOLOGY

1. To answer the research questions, I have conducted research in the three broad areas of O&S Costs Reduction listed below. The basic methodology was to a) conduct a review of the general acquisition information that directly relates to O&S Cost reduction, b) identify and assess the general initiatives underway within DOD which are focused on reducing O&S Cost across multiple systems and all Services, and c) conclude the research with the detailed review of the O&S Cost reduction efforts on a variety of DOD weapon systems. The last two areas, general initiatives and weapon systems initiatives, were grouped by “design” and “planning” since these categories represent the two general areas into which O&S Costs reduction efforts can be classified. From this comprehensive analysis the research will formulate a set of key roles that should be fulfilled by the Chief Logistician in reducing future O&S Costs.

GENERAL AREAS OF RESEARCH:

- **Acquisition Information related to O&S Costs Reduction**
- **General O&S Initiatives applicable to multiple systems**
- **Specific O&S Initiatives by various DOD weapon systems.**

2. To research these three broad areas, I utilized the following resources:

a. Department of Defense publications, policies, and directives

b. Published academic research papers

c. Internet websites and homepages

d. Books, periodicals, journals, and other electronic resources

e. Program management documentation from a specific weapon system

f. Reports, studies, briefings, and analysis on a specific weapon system

F. ORGANIZATION

This Thesis is divided into five chapters. Chapter I is the Introduction and provides the purpose, scope, methodology, organization, and benefits of the study.

Chapter II is the Background of O&S costs. The discussion defines O&S Costs, identifies their importance, characterizes the current environment, defines the history of recent O&S Cost reduction efforts, and defines the Project Manager's and Chief Logistician's basic roles in O&S Costs reduction.

Chapter III is a presentation of O&S Data in three broad areas: general acquisition information, general initiatives that apply to multiple systems, and specific data on selected weapon systems. The data in the last two categories is organized into two general classifications (design and planning) in order to develop a common baseline for data analysis. These two categories represent the two areas of logistics in which O&S Costs are believed to be determined by decisions made in the developmental phases of the life-cycle.

Chapter IV is the Analysis and has one section for each of the five secondary research questions. The sections will identify and discuss the specific strategic imperatives, key "design" activities, key "planning" activities, inhibitors, and needed changes to the Chief Logistician's status in reducing O&S Costs.

Chapter V is the Conclusions and Recommendations which summarizes the findings of the research and answers the research questions.

G. BENEFITS OF THE STUDY

The primary benefit of this study is to provide unique insight into the strategic reduction of O&S Costs for DOD weapon systems. The study identified the key roles of the person (Chief Logistician) who should be the most qualified to perform this strategic task. Since the highest life-cycle cost (Operation and Support) is determined during a short timeframe (Prior to the Critical Design Review) by a single organization (the Project Manager's Office), the ability to define and understand these key roles can have a major impact on the efficient use of DOD financial resources over future generations. Additionally, the study identified inhibitors and needed changes to the Chief Logistician's status in order that these roles may be more effectively fulfilled.

II. BACKGROUND OF OPERATION AND SUPPORT (O&S) COSTS

A. DEFINITION OF O&S COSTS

O&S Costs are typically defined as a function of time during the life-cycle of a particular system. Before defining O&S Costs, its parent category of life-cycle cost should be defined. The term “life-cycle cost” (LCC) is considered to be "the total cost to the Government for acquisition and ownership of a system over its useful life and includes the cost of development, acquisition, operation, and support (to include manpower) and where applicable, disposal (DSMC, Terms, 2001)." For defense systems, "LCC is also equal to Total Ownership Cost (TOC);" a term often used today to capture the totality of weapon systems costs from cradle to grave (DSMC, Term, 2001). Consequently, O&S Costs are a subset of LCC TOC and "generally consist of those costs which are accumulated after the item is developed, produced, and accepted by the Government. For example, O&S Costs include military pay to operate and maintain systems, fuel and consumables, depot maintenance, repair parts, procedures, training, and disposal (DSMC, Terms, 2001)." For this Thesis, only O&S Costs, which are directly attributable to a particular weapons system, will be considered. Figure 3-1 shows the life-cycle cost distribution for a typical weapon system. Milestone I is the beginning of the Demonstration & Validation phase; Milestone II is the beginning of Full-Scale Engineering Development, and Milestone III is the beginning of Full-Rate Production and Fielding. Under the new DOD acquisition process, these milestones have been re-named as Milestones A, B, and C with different narratives description. However, since the balance of research materiel relates to the old designations, this Thesis will continue to use those older designations for clarity and consistency.

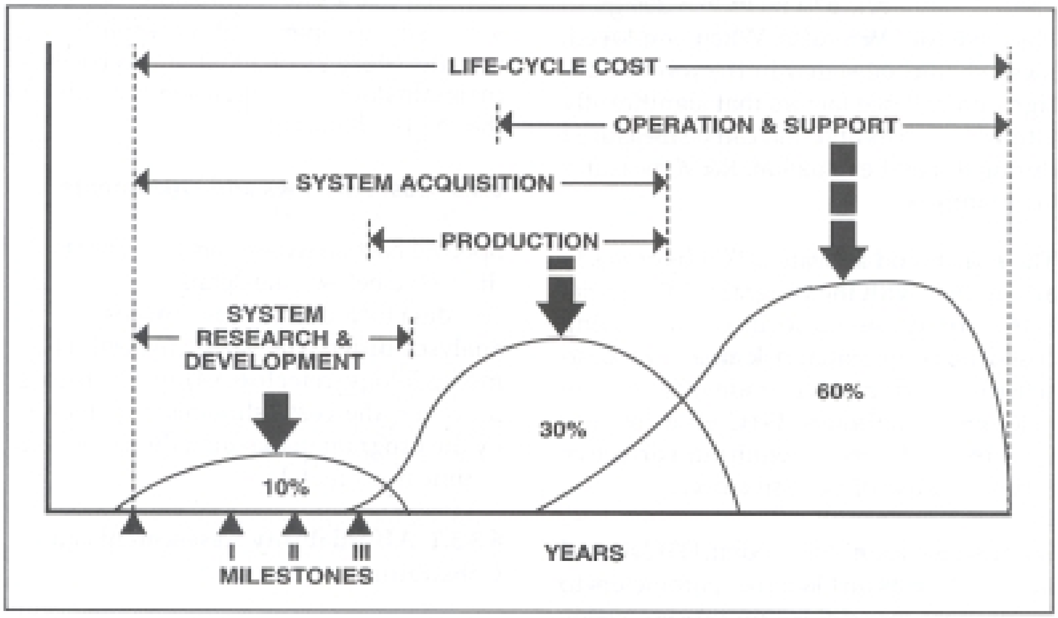

Figure 3-1. Life-Cycle Cost of a Typical Weapon System

B. IMPORTANCE OF O&S COSTS

As previously shown in Figure 3-1, O&S Costs are considered to comprise approximately 60% to 80% of a weapon system's life-cycle costs (DSMC, ILS Guide, 1999). Unfortunately, this percentage is rising rapidly due to the aging of the over-all force structure and the longer period of time that systems are being kept in the inventory. Instead of the traditional rule-of-thumb of a 20 to 30-year service life, the actual replacement cycle for military hardware is about 54 years (Augustine, 1994). Figure 3-2 displays the expected life-cycle of several DOD systems. The impact of this large extension of system life-cycles has enormous impacts to O&S Costs. Comparative data to other systems indicates that extensions to a service life period of 54 years results in O&S Costs rising to 98% of total LCC (McIlvaine, 2000)! However, this extension does not necessarily mean that O&S costs are escalating. These costs could remain relatively constant, but would be additive each year and would naturally comprise a greater percentage of LCC over the life-cycle. Regardless, the control of O&S Costs is the greatest single factor in minimizing the cost of ownership of military weapon systems.

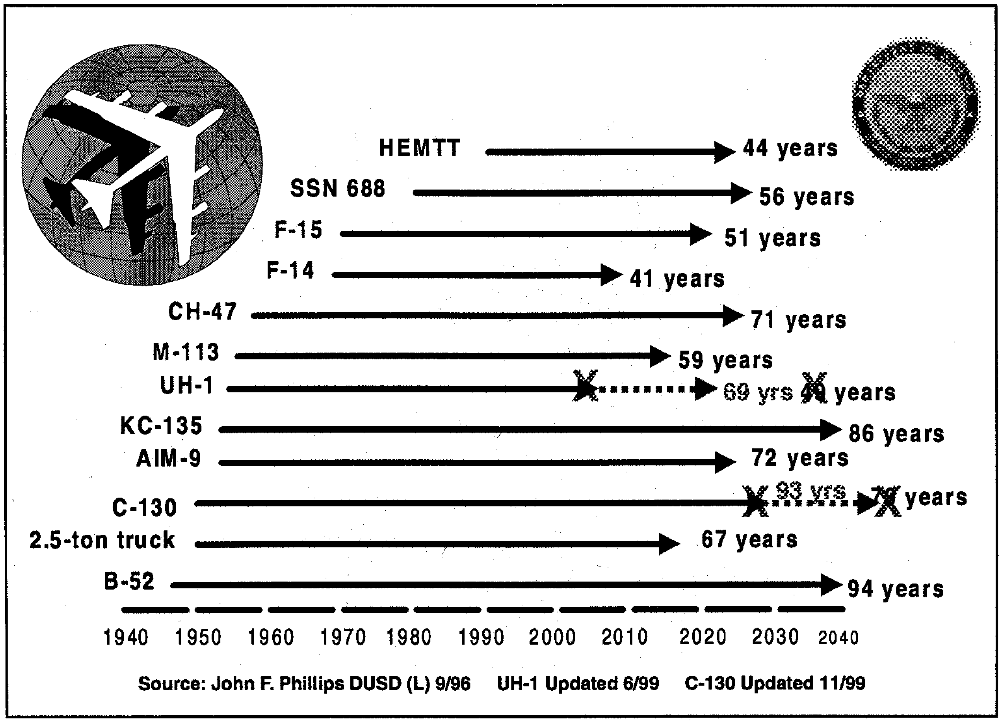

Figure 3-2. Defense System Life-Cycles

C. CURRENT ENVIRONMENT

1. User OPTEMPO

Not only is DOD using old equipment, but the operational tempo (OPTEMPO) of the forces continues to escalate as well. OPTEMPO is the rate, frequency, and extent to which our Services engage in military operations. General Erik Shinseki (Chief of Staff, Army) in a February 1998 statement before the House Armed Services Committee, observed that "since 1989, the average frequency of Army contingency deployments has increased from one every 4 years to one every 14 weeks (Gansler, 2000)."

2. Modernization Needs

Because of the aging of the force and the accompanying requirements for high readiness to satisfy an increased OPTEMPO, there has been a consistent transfer of money from procurement accounts to O&S accounts to satisfy these needs. This diversion of money from modernization accounts to readiness accounts is estimated to be $2 billion annually (Pallas, 2000). The resulting lack of modernization funding means that the aging military equipment could not be replaced or improved when desired. Furthermore, the aging equipment would still require more funding for support from the

modernization accounts. This conflicting dilemma has been labeled the “death spiral” by Under Secretary of Defense for Acquisition, Technology, and Logistics, Dr. Jacques S. Gansler (Gansler, 2000). The net result of this death spiral is that the total procurement accounts of DOD have fallen by 70% over the decade of the 1990s (Defense Systems Affordability Council, 1999).

3. Current Inventory of Weapon Systems

Unfortunately, at least over the coming years, DOD must continue to use these current weapon systems. Most defense analysts agree that the majority of the weapon systems we will use over the next two decades are either already fielded or currently under development. For example, nearly 75% of the Army’s systems that will be employed in 2010 already exist today (Website, Department of Army, TOC Organization).

4. Inherent Logistics Costs

The inherent cost of logistics within DOD is another key variable to address. Although sometimes difficult to relate to a specific weapon system, the total logistics cost within DOD accounts for 64% of their total obligation authority (McIlvaine, 2000). As a parallel effort to reduce the over-all logistics cost of owning specific weapon systems, the DOD leadership has developed quantitative goals for reducing the logistics portion of total obligation authority from the current 64% to 53% by 2005 (DOD: Into the 21st Century, 1999). Furthermore, this transformation strategy for logistics has two broad objectives. First, reduce the demand for logistics; principally through design activities. Second, to improve the ability to perform logistics principally through efficiency and effectiveness improvements (Gansler, 1998). Finally, the infrastructure cost of logistics is being aggressively attacked. Within DOD, a staggering 1.25 million civilians work in logistics and support-related jobs while the Services collectively spend approximately $80 billion annually on support (Gansler, 2000).

5. Specific O&S Trends

The O&S cost growth rates vary by service. The annual percentage rate for the period FY 1960-1999 was 1.9% for the Army, l.6% for the Navy, l.5% for the Air Force, and l.l% for the Marines. Since the military constitutes the highest O&S category,

particular attention is paid to the "cost per active-duty personnel." In FY 00-05, the projected cost is $126,300 per person and will continue to grow due to expanded personnel benefits, rising health-care costs, and increased demand for personnel-related support Services. Within the over-all O&S cost categories, disturbing trends continued to evolve. While the total O&S costs are only escalating slightly, the ratio expenditures between people (military & civilian) and purchases (e.g., parts, depot maintenance) is changing significantly. The "purchases" element continues to rise at the expense of "people." Consequently, pressure will continue in military pay accounts to do operations and maintenance tasks with less people in less time (Goure, 1999).

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III. DATA

A. RECENT EFFORTS TO REDUCE O&S COSTS

1. Baseline Efforts

The reduction of O&S Costs has long been a goal of DOD, but has not received the same level of attention as other program objectives. To help remedy this lack of focus, DOD has established "supportability as equal to performance, cost, and schedule" for the management of any defense weapon program (DOD Directive 5000.1, 2000). However, since supportability of weapon systems has historically been the responsibility of the Services logistics and materiel commands, the typical Project Manager has struggled with the dilemma of how to make supportability "equal in importance" when he does not have the supportability mission.

2. Recognition of O&S Cost Commitment

Although Project Managers have not had the responsibility to execute the supportability mission, an accepted fact of acquisition indicates that the Project Manager is in the best position to determine future operation & support costs. Figure 4-1 shows that approximately 95% of LCC have already been committed by the time a system conducts its CDR, although only about 15% of the actual costs have actually been incurred. This 95% accumulation occurs during the phases of the life-cycle when a Project Manager (PM) is in-charge of the weapon system's development. Consequently, a PM can utilize numerous developmental activities and tools to significantly impact the future O&S Costs for his weapon system.

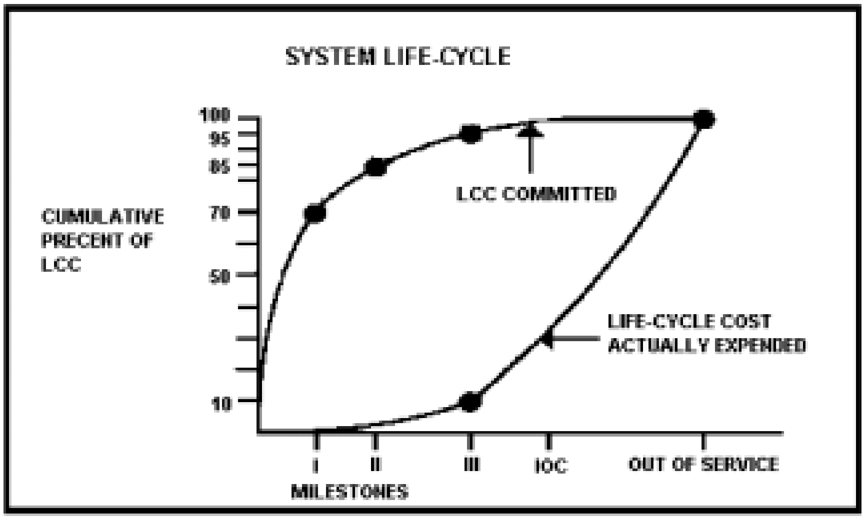

Figure 4-1. Typical Life-Cycle Cost (LCC) Commitment

3. Recent Initiatives

Partially as a result of the PM's unique position, a series of recent initiatives have given the PM much greater responsibility in the area of supportability and O&S Costs reduction. The recent emphasis is centered around Section 912(c) and Section 816 of the National Defense Authorization Act for Fiscal Year 1998 as well as a series of DOD policies and directives promulgated in response to this congressional act. As related to this Thesis, this act resulted in the formation of the Defense Systems Affordability Council (DSAC) to steer DOD total ownership cost reduction efforts, the designation of 30 pilot programs (10 per each of the three Services) to lead the efforts in DOD R-TOC, and the designation of Project Manager Oversight of Life-cycle Support (PMOLCS) to empower the PM with a substantive role in O&S Costs reduction (Pallas, 2000). As parallel efforts, DOD and the various Services have instituted a wide variety of general O&S Costs reduction efforts across multiple systems.

4. Project Manager's Role in O&S Cost Reduction

a. Genesis

At ground zero of DOD's recent R-TOC and O&S Costs reduction efforts is the Project Manager. Historically, the PM's charter has been limited to developing, producing, and fielding a weapon system. This charter included the responsibility to design and plan the logistics support system. After fielding, the responsibility for

executing the support of the weapon system fell on the Service's logistics and materiel commands. This transition point of responsibility has always been a gray area since most systems require several years to field. Furthermore, this extended fielding period mandated supportability concurrent with production & fielding and usually involved several post-fielding modifications, which were often managed by the PM. Finally, since the PM has been responsible for designing and planning the support system, but not executing that mission, an established criticism has been that the PM does not adequately consider the implications of support decisions during development since the actual impact of those decisions will be the responsibility of the logistics and materiel commands. Consequently, most PM's have historically been involved in supporting weapon systems as a coordinated effort with the Service's logistics and materiel commands. However, the PM's specific role has always been clouded by lack of clarification on the PM's specific scope of authority, responsibility, and accountability.

b. Recent Policy Statements

Unfortunately, the recent policy statements have not clarified the PM's specific role. For example, within the Army, the initial catalysts for PM involvement in life-cycle management (Department of Army Memo, 1997) and O&S Costs reduction (Department of Army Memo, 1998) were acknowledged in a follow-on DA memorandum (Department of Army Memo, 2000) that the previous two memorandums "have created confusion regarding the roles and responsibilities of program management and sustainment personnel as well as weapon systems transition requirements." The follow-on memo rescinded the two previous memos, maintained the PMs responsibility for life-cycle management, but left this responsibility dependant upon not "jeopardizing AMC/MACOM Army-wide readiness and supportability responsibilities."

c. The Path Forward in PM Life-Cycle Management and R-TOC Reduction

In spite of these policy issues, the PM remains charged with a complex responsibility with limited authority and control. The 30 pilot programs have become the central hub of activity for the PM's quest to reduce TOC and O&S Costs (Pallas, 2000) and will thus form the principal basis from which to conduct the research for this Thesis at the weapon system level. DOD acknowledges these inhibitors and describes the

challenges and expectations of the PM in future activities for both new and fielded systems (DOD: Into the 21st Century, 1999).

> ***Giving New Authorities to Program Managers of Both New and Fielded Systems: Program Managers' accountability for life-cycle issues can be improved by increasing visibility into related processes, giving them either direct control or, as a minimum, a strong influence over tradeoffs among research and development, acquisition, operating, and support costs. They must be held directly accountable for resources they directly control. Where operational or economic considerations dictate sharing of resources, individual Program Managers must be held accountable for clear and timely articulation of actions to reduce life-cycle costs of their systems.***

5. Chief Logistician's Role

Although virtually all of the literature today focuses on the PM as the "dragon slayer" for O&S Costs reduction, the Project Manager’s task is actually performed by a large staff of project office personnel who are both core to the project office and matrixed from the supporting commands. While the PM is the leader and ultimate decision-maker of the organization, the vast majority of the actual work is accomplished by this staff of 40-150 people. Typically, the Project Manager’s principal action officer for reducing O&S Costs is the Chief Logistician. This individual is a senior civilian or military logistician who heads the logistics/support division; one of 3-6 divisions in a typical project office. The Chief Logistician must manage a matrixed group of logisticians collocated in the project office as well as provide oversight to a group of non-collocated logisticians in the Service’s materiel or logistics command. The latter presents a particularly difficult challenge in that the non-collocated logisticians provide critical logistics support in key ILS areas (e.g. Inventory Management, New Equipment Training, Publications, Maintenance Engineering) but do not report directly to the Chief Logistician. Within the PM office, the Chief Logistician is charged by the Project Manager to manage the entire spectrum of Integrated Logistics Support (ILS) elements for the program and to make the necessary recommendations to the PM for efficiently designing, producing, fielding, and managing the support system. Consequently, in the same way a Commander-in-Chief charges his divisional commander to execute his

particular sphere of responsibility, the PM charges the Chief Logistician to reduce the future O&S Cost by effectively executing his or her divisional responsibilities. Therefore, the remainder of this research will study this topic from the perspective of the Chief Logistician but within the context of the Project Manager's over-all charter to reduce O&S Costs as an integral part of the development of a weapon system.

B. ACQUISITION INFORMATION ON O&S COSTS

The following data is a synopsis of the general acquisition information related to O&S Costs reduction within DOD. The data is a summary of the most salient information, which directly involves the policies, techniques, directives, and procedures of O&S Cost reduction.

1. Past Acquisition Practices

A substantial amount of acquisition research indicates that current O&S Costs are directly attributed to the acquisition practices of the past. In the 1960 to 1980s timeframe, engineering practiced "Lone Ranger Design" through the "Art of Sequential Engineering." The engineer, operating solo, sequentially designed a system to meet the point-design requirements with neither significant involvement of other parties nor an assessment of the design's impact to other disciplines or the life-cycle cost of the system (McIlvaine, 2000). The user's last involvement was limited to early front-end requirements determination and challenges to questionable or flexible requirements were strongly discouraged. Logistics considerations followed and supported whatever the engineer created. When mistakes were made, multiple engineering changes and expensive field modifications followed. The result was an ill-conceived, huge, and lengthy logistics tail that was both inefficient and frequently ineffective. Contractor support was discouraged, asset visibility was limited, supply chain management disintegrated, unplanned overhaul programs and service-life extensions were common, and post-production support planning for supply and maintenance was restricted (McIlvaine, 2000). With the developmental pressure to control costs, the Design-to-Cost (DTC) climate resulted in logistics considerations being traded-off for near-term development needs or production over-runs (Kausal, 1996). Still, cost over-runs became commonplace. "Despite the implementation of more than two dozen regulatory and

administration initiatives" resulting from the Packard Commission's recommendations to reduce cost over-runs, there has "been no substantial improvement in the cost performance of defense programs for more than 30 years (Christensen, 1999)."

2. Current Acquisition Directives

The latest 2001 DOD 5000 series contains a major new emphasis on Reduction of Total Ownership Costs (R-TOC). This unprecedented highlighting of the O&S Costs arena contains at least five major emphasis areas as listed below. Furthermore, the directive requires that, when reducing total ownership costs, "cost must be considered as a requirement that drives design, procurement, and support (DOD: Briefing: The New DOD Systems Acquisition Process, 2000)."

Five Major Emphasis Areas to Reduce Total Ownership Costs:

- ***Use Market Research and Commercial Products to increase competition***
- ***Use Open System Architecture to reduce the cost of technology insertions***
- ***Use Dissimilar Competition in non head-to-head alternatives to meet capability needs***
- ***Increase use of Simulation-Based Acquisition to reduce costs for hardware prototype***
- ***Reprocurement Reform based on business case analysis of predicted life, technology insertion opportunities, and cost reduction potential.***

Furthermore, in response to Section 912c of the National Defense Authorization Act of 1998, the Secretary of Defense identified the following major actions for "re-engineering the sustainment process (Pallas, 2000):"

- ***Re-engineer the Product Support Process to use Best Commercial Practices***
- ***Competitively support product support***
- ***Modernize through Spares***
- ***Establish Project Manager Oversight of Life-Cycle Support***
- ***Greatly expand Prime Vendor and Virtual Prime Vendor Support***

3. General Measures of Logistics

One of the first steps in identifying the factors which contribute to O&S Costs growth is to first identify the general measures of logistics. One of the "classic" textbooks on Logistics Engineering (Blanchard, 1992) categorizes the measures of logistics as listed in Figure 4-2 below. The data indicates that each of these measures has a direct relationship to O&S Costs.

General Measures of Logistics (with examples of specific metrics):

a. *Reliability: failure rates of numerous combinations*
b. *Maintainability: mean corrective/preventive maintenance times*
c. *Supply: operating level, safety stock, reorder cycle, pipeline*
d. *Test & Support Equipment: quantities, locations, intended function*
e. *Organizational: direct maintenance labor times, personnel attrition*
f. *Facilities: item turnaround time, facility utilization, total cost per month*
g. *Transportation & Handling: capacities, cost per shipment/ton*
h. *Software: failure rates, addressability errors, and calculation errors*
i. *Availability: inherent, achieved, and operational*
j. *Economic: total life-cycle cost, ownership cost, cost growth*
k. *Effectiveness: system performance and physical parameters*

Figure 4-2. General Measures of Logistics

4. Acquisition Logistics

Military Handbook 502 (MIL-HDK-502) is the principal roadmap for performing acquisition logistics. This guidance-only document provides an excellent framework for identifying the various methodologies for reducing O&S Costs as an integral part of the systems engineering process. The handbook indicates the major supportability criteria that should always be considered as part of the total system design process are cost, equipment readiness, and manpower/personnel constraints (DOD: MIL-HDK-502,1997). The areas of the handbook which contained key emphasis on O&S Costs reduction were supportability analysis, techniques of developing supportability requirements, critical processes, and maintenance planning.

a. Supportability Analysis

The handbook unequivocally indicates that “supportability is a design characteristic” and that “the early focus of supportability analysis should result in the establishment of support-related parameters or specification requirements” which are “expressed quantitatively and qualitatively." Consequently, achieving affordable system support is a “result of sound systems engineering." To meet this objective, the supportability analyses should accomplish the following two broad objectives:

> ***1st: Ensure Supportability is a Performance Requirement. Supportability requirements are “not to be stated as distinct logistics elements, but instead as performance requirements that relate to the system’s operational effectiveness, operational suitability, and life-cycle cost reduction.” The initial output should be an integrated Operational Requirements Document (ORD) which reflects the operational and support concept. From this ORD, the supportability analysis should define the “key supportability factors” which most significantly impact the system. In general, these factors include deployment, mobility, mission frequency and duration, human systems integration, anticipated service life, standardization and interoperability, and supportability risks.***

> ***2nd: Ensure Optimal Support System Design. The key is to design the system with a balance between the total system and support. The balance is a function of neither maximizing or minimizing the other, but seeks to develop an optimum point at which supportability is in-balance with the remainder of the system elements. The specific “design influence for supportability” activities vary by system and are a product of the logistics requirements defined in the following section.***

b. Supportability Requirements

The beginning point for each supportability requirement should be found in an operational requirement. The regulatory guidance for preparation of the Operational Requirements Document (ORD) requires that every paragraph, except for the

paragraph on "threat," should contain logistics information. The specific ORD areas which should include supportability requirements include the general description of the operational capability, the readiness rates, maintenance plans, mean down time in operational environments, support equipment, human systems integration, stockage levels of materiel, computer resources, transportation, standardization, and interoperability (DOD: MIL-HDK-502, 1997). Figure 4-3 summarizes the typical reliability and maintainability requirements for weapon systems.

	Reliability	**Maintainability**
Readiness (or availability)	mean time between downing events	mean time to restore system
Mission Success (or dependability)	mission time between critical failures	mission time to restore functions
Maintenance Manpower Cost	mean time between maintenance	direct man-hours per maintenance action
Logistic Support Cost	mean time between demands	total cost to remove a part at all levels of maintenance

Figure 4-3. Typical Reliability and Maintainability Requirements

The handbook defines at least two major challenges for the logistician in accomplishing this "design influence" activity. First, the supportability requirements must be expressed in performance terms and not direct “how” they are to be achieved. These performance specifications have revolutionary impacts on the logistics community, which has always relied upon detailed Government-controlled specifications. The implementation of performance specifications into the logistics world continues to evolve, but is riddled with numerous difficulties. Second, the logistician must resolve inevitable conflicts with the design engineers over trade-offs of design characteristics for support needs and must be able to defend the requirements they propose. Figure 4-4 provides specific examples of support requirements for a major weapon system program, the Air Force’s F-16 aircraft (DOD: MIL-HDK-502, 1997).

SUPPORTABILTY RELATED DESIGN FACTOR
FOR THE F-16

Terms:	Range/Value:
Weapon system reliability	.90 - .92
Mean time between maintenance (inherent)	4.0 - 5.0 hrs.
Mean time between maintenance (total)	1.6 - 2.0 hrs.
Fix rate	60% in 2 hrs. 75% in 4 hrs. 85% in 8 hrs.
Total not-mission-capable rate maintenance rate	8%
Total not-mission-capable supply rate	2%
Sortie generation rate	classified (see req. doc.)
Integrated combat turn around time	15 min.
Primary authorized aircraft airlift support	6-8 C-141B equiv.
Direct maintenance personnel	7 to 12 AFSCs
Reduced number of Air Force Specialty Codes	4 to 6 AFSCs

Figure 4-4. Supportability Design Factors (F-16 Aircraft)

Ultimately, the supportability needs must be translated into specific requirements. A related document states that defining these "essential qualitative and quantitative readiness and logistics supportability requirements in operational concepts and requirements documents is the most effective way for users to influence the design of their systems (Department of Air Force, Instruction 10-602, 1994)." Figure 4-5 is a representative list of terms which can be use to define supportability requirements.

Terms for Defining Supportability Requirements		
1. Administrative and Logistics Delay Time	25. Integrated Combat Turnaround Time	49. Restoral Time
2. Alert Reliability	26. Integrated Diagnostics & Effectiveness	50. Scheduled Maintenance
3. Availability	27. Life Unit	51. Service Life
4. Built-in Test Effectiveness	28. Logistics Reliability	52. Software Error
5. Captive Carry Reliability	29. Maintainability	53. Software Failure
6. Combat Capability	30. Maintenance Action	54. Software Maintainability
7. Corrective Maintenance	31. Maintenance Event	55. Software Maturity
8. Critical Failure	32. Maintenance Event Time	56. Software Reliability
9. Defect	33. Maintenance Man-Hours Per Life Unit	57. Stock Availability
10. Degradation	34. Maintenance Turnaround Time	58. Storage Life
11. Dependability	35. Manpower Spaces Per System	59. Subsystem Break Rate
12. Deployability	36. Mean Downtime	60. Subsystem Utilization Rate
13. Dormant Storage Reliability	37. Mission Capability	61. Support Structure Vulnerability
14. Downing Event	38. Mission Effectiveness	62. Sustainability
15. Downtime	39. Mission Reliability	63. System Deployability
16. Environmental Stress Screening	40. Mobility	64. Time Between Maintenance Events
17. Failure	41. Operational Availability	65. Time Between Removals
18. False Alarm	42. Operational Effectiveness	66. Time to Assemble & Prep for Delivery
19. Fault	43. Operational Suitability	67. Time to Restore Function
20. Fault Isolation	44. Preventive Maintenance	68. Time to Troubleshoot
21. Fix Rate	45. Readiness	69. Unconfirmed Fault Indications
22. Incoming Reliability	46. Reliability	70. Unscheduled Maintenance
23. Inflight Engine Shutdown Rate	47. Reliability Growth	71. Utilization Rate
24. Inherent Availability	48. Repair Time	72. Vertical Testability

Figure 4-5 Terms for Defining Supportability Requirements

c. Critical Processes

The handbook emphasized the importance of effectively managing critical processes. A related Air Force guide for Critical Process Assessment Tools (CPATs) offers some keen insight into the design of the support system. The basic principal is that “effective logistics is all in the design.” The “logistics engineer must be an advocate for their point of view as well as a respected participant and full member of the system engineering team.” Credibility is a critical factor whereby “logistics parochialism is inversely proportionate to logistics believability.” The “logistics system and money are inextricably tied” to one another, mandating that an adequate up-front monetary

investment provides assurance of the optimum logistics support structure which is resolved through a comprehensive Life-cycle Cost (LCC) analysis (CPAT for ILS, 1998). The CPAT further defines "Logistics as a System Engineering Discipline" consisting of the following three fundamental disciplines:

- System Engineering - consisting of the processes of the supportability concept, analysis, architecture, and technical parameters. In particular, the key system performance parameters are identified as:

  1) Availability - the degree to which a system is in an operable state and ready to start its mission.

  2) Dependability - the degree to which a system is operable and capable of performing its mission (given system Availability as the start of its mission).

  3) Downtime – that element of active operational time when the system is not in a condition to perform its required function (mission).

  4) Single Point Failure - the failure of an item which would result in a system failure, and is not compensated for by redundancy or alternative operational procedures.
- Design Engineering - consisting of the reliability and maintainability foundation, human factors engineering and safety considerations, configuration management, and concurrent engineering.
- Logistics Integration - consisting of the external interfaces, the ILS internal interfaces, and the Government-furnished equipment and materiel.

d. Maintenance Planning

A consistent theme throughout a review of data on O&S Costs reduction is the importance of maintenance planning. Maintenance planning is defined as "the process conducted to evolve and establish maintenance concepts and requirements for the lifetime of a materiel system (DSMC ILS Guide, 1999). In an Air Force guide on the subject, maintenance planning is characterized as "probably the most significant factor influencing a program's support strategy and life-cycle support costs." Maintenance planning is further identified as "critical to subsequent system and logistics

development," as the "key to all other logistic element planning and requirements," and is the "backbone of the overall support strategy" (CPAT for Maintainability, 1998).

1) Objectives

In general, the objectives of maintenance planning are to translate the maintenance approach stated in requirements documents into maintenance task requirements, to define the actions and support resources needed to maintain items at all levels of maintenance, and to define specific criteria for repair times, locations, frequencies, diagnostics, etc. at each level of maintenance. In short, the data indicates that maintenance planning is the logistics engineer's primary tool for designing and executing the support system. For example, Figure 4-6 is a listing of specific maintenance design requirements for the Navy's F-18 aircraft, which have an impact to TOC.

F-18 MAINTENANCE REQUIREMENTS

Direct maintenance:

Man-hours/flight hour	11.02
Operational availability	80%
Turn around time (max. 3 men)	15 min.
Mean time to repair	1 hr. 46 min.
Fault isolate time	90% in 5 min.
Fault isolate time	100% in 10 min.
Engine change	21 min. (4 men)
Radar remove and replace	21 min. (2 men)

Figure 4-6. Maintenance Design Requirements (F-18 Aircraft)

2) Process

The maintenance planning process is typically described based on the particular phase in the system life-cycle. From a review of the literature, the three foundational steps of the maintenance planning process are generally defined as follows (CPAT for ILS, 1998):

1st: Identify the repairable items which are critical from a system engineering perspective.

2nd: Determine the Corrective and Preventive Maintenance requirements for the most critical failures and to determine the most affordable level of maintenance repair tasks for the identified failure modes.

3rd: Perform maintainability engineering task analyses to document the needed resources (tools, parts, training, documentation, etc.) to perform the necessary maintenance.

The data also indicates that the overall critical process of maintainability is to successfully transition the operational document requirements to specific maintainability criteria in the system design. Specifically, the critical processes are to establish the inter-related supportability performance, operational availability, and system affordability requirements that must be expressed in measurable and testable maintainability terms (CPAT for Maintainability, 1998). Finally, the importance of a Reliability-Centered Maintenance (RCM) program is repeatedly emphasized to selectively apply scheduled maintenance in order that critical failures can to anticipated, minimized, and/or prevented (Department of Air Force Instruction 21-103, 1994).

3) Impact of Acquisition Reform

Acquisition reform has significantly impacted the conduct of maintenance planning. The transition to performance specifications spelled the "demise of Mil-Standard 1388 better known as Logistics Support Analysis (LSA)" which was the mature and battle-hardened process for LSA and detailed maintenance planning. This military standard has been replaced by a variety of similar processes such as Flexible Sustainment whereby performance-based specifications are used to link maintainability requirements to reliability and to understand how changes in maintenance plans "triggers" changes in asset management (CPAT for Maintainability, 1998).

5. O&S Cost Reduction Data

The airwaves of the DOD acquisition community are currently filled with information on O&S Cost Reduction and Reduction of Total Ownership Cost. The following information provides a synopsis of several key activities of O&S Costs reduction within DOD and the various Services.

a. Senior Leadership Vision

In a May 1999 memorandum (Pallas, 2000), the Defense Department defined the following "three large potential savings areas" for Reduction of the Total Cost of Ownership (R-TOC) in the 30 DOD pilot programs as:

1) Reduce demand from weapon systems via reliability and maintainability improvements.
2) Reduced supply chain response times leading to reduce spares, a reduced system support footprint, and reduced depot needs.
3) Competitive sourcing of product support leading to streamlining and overhead reduction.

b. R-TOC Implementation Guides

Each of the Services has implementation guides on R-TOC. Typically, each guide follows a general pattern of first defining the cost drivers and targets of opportunity and then implementing a specific cost reduction plan (Website, Affordable Readiness). The overwhelming majority of data dealing with O&S Costs reduction relates to fielded systems (rather than how to reduce O&S costs for systems in development). Interestly, the R-TOC guides seem to suggest that readiness and R-TOC are mutually exclusive. A relevant concern should be that with declining expenditures, (in the quest for cost reduction), there may be a direct impact to system readiness levels. Each Service defines the major areas of opportunity for its systems. For example, the U.S. Navy Air Systems Command identified the following principal areas of cost (TOC Implementation Guidebook, 1998):

1) Inventory: Aircraft, engines, spares, support equipment, and training devices

2) Manpower: Military, civil service, and contractor

3) Technical Data: Publications, engineering drawings, software

4) Infrastructure: Buildings, facilities, test & evaluation equipment, production tooling

The total breakdown of O&S Costs for a particular service or commodity provides an excellent framework for evaluating what cost drivers contributed to these costs. The breakdown of the principal O&S Costs drivers for the U.S. Navy's Air Systems Command is defined in Figure 4-7 below (TOC Implementation Guidebook, 1998).

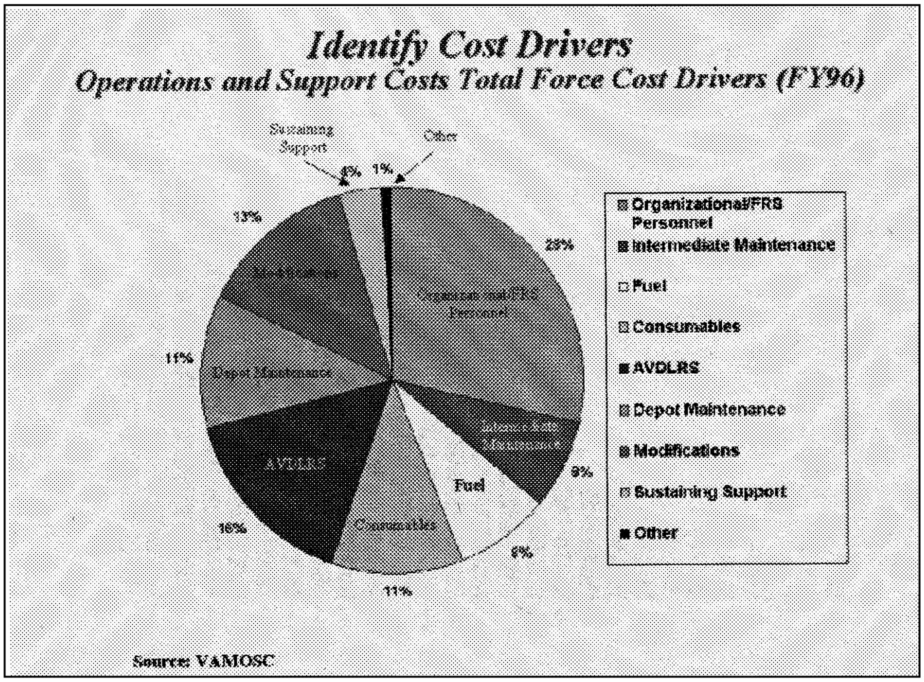

Figure 4-7. Principal O&S Costs Drivers for NAVAIR

Each service is collecting the early lessons learned in their cost reduction efforts. For example, the principal lessons learned by the Army include the importance of reliability and maintainability improvements (with emphasis on built-in capabilities), the good return-on-investment decisions by reductions in depot maintenance and supply chain cycle times, and the economical benefits of competitive outsourcing of product support (Website, Department of Army R-TOC).

c. Progress To Date

The progress on O&S Costs reduction remains mixed. R-TOC reports from the Services' 30 pilot programs indicate substantial progress in many areas. Inhibitors such as lack of incentives, investment funding, and funding control remain a problem. Approximately half of the 30 systems are "on-track" to meet their goals with the remainder either "falling short" or "unavailable" (Website, DOD R-TOC). Additionally, two General Accounting Office (GAO) reports on the Army (Report, GAO #00-197, 2000) and Air Force (Report, GAO #00-165, 2000) indicate that efforts are falling short due to lack of priority, insufficient mechanisms, improperly assigned responsibility, and minimal incentives.

C. GENERAL INITIATIVES TO REDUCE O&S COSTS

The research data identifies the following initiatives that are underway within DOD or a particular service to directly or indirectly reduce O&S Costs. The initiatives are categorized by whether they are a design or plan-related activity.

1. Design-Related Initiatives

a. Reducing Logistics Demand through Design

This grassroots effort is simply to reduce the demand for logistics through more reliable, available, and maintainable designs. Ultra-reliability, one of the six topical pillars of the Army After Next (AAN), seeks to reduce this demand by achieving inherent reliabilities of greater that 95%, implementing horizontal technology integration with common architecture across families of systems, and using smart software to simplify the basic design of systems (Renee, 2000). Technological approaches to design-out demand include nano-technology (building items one molecule at a time for better reliability) and mechanical extensions of microelectronics. Also known as the "second silicon revolution," microelectronics has unique opportunities for reducing logistics demands for ammunition, petroleum, and food (Shipbaugh, 2000). Other initiatives include biometrics (developing novel synthetic materials and sensors), mobile wireless communication, intelligent systems, smart structures, compact power sources, and micro-miniature multifunctional sensors (Pollard, 1999). As a specific example, Future Combat Vehicles (FCV) in the Army have numerous opportunities for designing-out demand through on-board, real-time, self-reporting prognostics, advanced nonhydrocarbon-based fuels and propulsion systems, and reduced corrosion by curving metal surfaces at joints (Reed, 2001).

b. Open Systems Architecture

Open systems architecture is an approach whereby the system's hardware and software is designed to easily accept future technical upgrades and modifications throughout the system life-cycle. The critical elements of design include the system interfaces (connectors, buses, operating systems), system capacities (memory, throughput, power), and formats (software, video) (NPS Brief, 2001). The key activities

in applying open systems architecture to reduce life-cycle supportability costs consist of the following (Hanratty, 1999):

1) ***Focus on the key interfaces that are most likely to change, have increased requirements, have increased replacement frequencies, or have high costs.***
2) ***Use open standards for these interfaces that are supported by the broader community***
3) ***Use a modular design approach with well-defined interfaces between modules***
4) ***Identify the lowest level Government control and anticipate how this may change over time***
5) ***Verify all performance requirements and re-evaluate their stringency***
6) ***Implement consistent conformance management practices***

c. Modular Design

Modularity is a design approach whereby hardware is structured in standardized dimensions for easy assembly/disassembly. This fundamental design feature allows great flexibility and efficiency during repair, modification, and improvements. Modularity improves the ability to adapt to change and provides systems the ability for continuous, uninterrupted support (Elsmo, 1999).

d. Modernization through Spares/Technology Insertion

This practical initiative seeks to utilize the continual purchase of spare parts to modernize the system. Replacement spares have the latest-and-greatest capabilities incorporated into the item which improves reliability and maintainability and thus reduces O&S Costs over the long term (Gagnon, 1999).

e. Affordable Readiness

Affordable readiness is a basic tool aimed at making every programmatic decision within the context of affordability, particularly in terms of supportability costs. The types of implemented initiatives include equipment redesign, reliability improvements through maintenance changes, obsolescence avoidance, engine-related redesign activities, test program set and software development changes, and maintenance process changes. The implementation of these initiatives is dependant upon the expected

return-on-investment in terms of improved readiness (Website, Department of Navy, Affordable Readiness, 2001).

f. Recapitalization

This approach is the systematic upgrade of currently fielded systems to attempt to turn the "age-clock" back to zero. Recapitalization uses maintenance and modification techniques to extend service life, reduce O&S Costs, improve reliability and maintainability, and enhance capability. The Army has an extensive recapitalization program for most of its major weapon systems using Research, Development, Test, and Evaluation (RDT&E) and Operation and Maintenance (O&M) funding (Website, Department of Army, R-TOC, Recap).

g. Retail Logistics Revolution

While the wholesale logistics systems tends to receive the majority of attention, numerous activities are underway within the retail structure to achieve substantial O&S Costs reductions. The battlefield is being redesigned to modular units, centralized logistics operators, new theater support commands to maximize throughput, minimized handling, and increased velocity of operations. Automation is driving this re-design activity. New technologies such as the Palletized Loading Systems (PLS), Container Roll In-Out Platforms (CROP), and Movement Tracking Systems (MTS) will enable substantially more effective distribution systems. Information-age technology for combat support and combat service support systems will greatly improve situational awareness of logistics needs to promote a seamless logistics pipeline throughout the retail structure (Witt, 1999).

2. Plan-Related Initiatives

a. Single Process Initiative

This DOD-wide initiative with industry "facilitates the elimination of the distinction between traditional defense and commercial suppliers (Gansler, 1998)". This initiative ultimately becomes the mechanism by which DOD expedites the transition of existing Government contracts to common best processes. The principal goal of the single process initiative is to convert DOD to commercial process to improve effectiveness and reduce costs. For example, changes to contracts negotiated by the

Defense Contract Management Command (now Agency) (DCMC) within a single year have resulted in direct savings of $30 million and a cost avoidance of $444 million (Gansler, 1998).

b. Lean/Focused Logistics

As the name implies, lean logistics is merely a system of innovations to revolutionize the culture of how supportability is performed. Lean logistics is defined as "an interrelated series of logistics initiatives that promote combat capability, enhance our war-fighting sustainability, shrink the logistics footprint, and reduce infrastructure (Cusick, 1999)." Focused logistics initiatives include accelerated movement of assets through transportation and repair cycles, downsizing logistics resources, implementing computer-based training, developing more reliable simulations and modeling, and utilization of state-of-the-art decision-making tools. The actual lean logistics innovations which have produced significant savings include two-level maintenance concepts, high-velocity transportation, door-to-door transportation, repair and return packaging, just-in-time practices, mail-like matter movement, smaller tailor stocks, and electronic data exchange (Morrill, 1995). Finally, the total Logistics Footprint of the support structure can be reduced through robotics, unmanned vehicles, intelligent agents, smart/brilliant munitions, and advanced information technology (Houck, 1999).

c. Total Asset Visibility

Total Asset Visibility (TAV) is "an automated capability that will dramatically improve the ability of soldiers, logisticians, and managers obtain information on the location, quantity, condition, and movement of assets through the logistics pipeline." Ultimately, massive cost savings are anticipated by reducing the quantity of parts needed to fill a more streamlined logistics tail (Butler, 1999).

d. Prime Vendor Support (PVS) and Total System Performance Responsibility (TSPR)

Prime Vendor Support (PVS), also known as Fleet Management, is a partnership of Government with industry by having "the prime contractor assume responsibility for total performance of a weapon system and its modernization by integrating modernized parts (Gavora, 1999)." This revolutionary concept capitalizes on contractor best practices and innovation to achieve the cost reductions. The PVS

initiatives have major challenges due to integration of contractors with the wholesale logistics system, loss of organic capabilities, contractors on the battlefield, validation of savings, and a variety of other factors. Closely related to PVS is Total System Performance Responsibility (TSPR) whereby a contractor is responsible for system modifications, integration, and sustainment tasks for a weapon system while the Government remains responsible for over-all execution. Significant savings have been achieved in reducing the size of the Air Force program offices, reducing Navy aircraft total O&S Costs, and savings from partnerships between the prime contractor and Government depots (Luddeke, 2000).

e. Commercial Item Acquisition

The expanded use of commercially available items provides opportunities for reduced cycle times, faster insertion of new technology, lower life-cycle costs, greater reliability and availability, and support from a robust industrial base. The use of these commercial items is now the "preferred approach" for meeting operational requirements (DOD Directive 5000.1, 2000). The use of commercial items clearly requires renewed emphasis on traditional business and engineering practices and requires the thorough understanding of the mandates of the commercial marketplace. However, the data indicates that the benefits far outweigh the obstacles. The use of commercial items continues to demonstrate remarkable improvements in the cost and performance of supportability (Report, OSD, 2000).

f. Operationalizing Acquisition

Operationalizing acquisition is a fairly radical change of focus in military acquisition. Since the primary objective of the military is mission, not profit, commercial business practices are not working very well in many areas of the military environment. Many believe the time is right for acquisition to return to its military roots by converting program directors and managers into program commanders and eliminating matrixed functionals, allowing the "commanders" to be in total charge of their mission (Jannazo, 1999).

g. Logistics Modernization

Springing from DOD's commitment to innovative approaches to performing business, the Wholesale Logistics Modernization Program (WLMP) will overhaul the Army's Logistics System by replacing the existing antiquated logistics and depot maintenance system. The digitized system is intended to successfully rival any commercial system. The contract for this logistics automation will be awarded to one contractor, with the possibility of extending the contract and expanding its scope (Ferlise, 2000). The WLMP also involves converting existing Government functions to the private sector. Specifically, the WLMP contract requires the winning offeror to provide reengineering and modernization Services for the Army's current wholesale logistics system (Lea, 2000).

h. Training & Reorganization

The Department of Defense (DOD) has been cutting logistics funding for years and is now seeking to privatize logistics operations to pay for recapitalization. As a result, the future of the current logistics workforce must be changed. To support the deployment and sustainment of an armed force, DOD needs certain skills, including those necessary to define outsourcing and strategies and to measure results. As a minimum DOD needs to expand the training of the logistics workforce to ensure that future logisticians have the skills needed to manage core logistics tasks in a changing environment, reorganize some logistics structures, and elevate logistics representation at the most senior Defense Department levels commensurate with its cost and impact (Jones, 1997).

i. Industry Integrated Logistics System (I^2LS)

This approach combines elements of military and corporate strategies to allow DOD to take links out of the supply chain. A good example of shortening the supply chain was done in the 1960's by Sam Walton. He realized that by cutting links out of the chain and allowing goods to "leapfrog" from the manufacturer directly to the stores, he would save both delivery time and product costs. Today, modern civilian manufacturing and distribution systems have reduced delivery response times from weeks to just a few days by leap-frogging over traditional intermediary points. Taking

advantage of these efficient systems will greatly improve component availability while reducing the inventory costs of existing Government wholesale operations (Boyd, 1998).

D. WEAPON SYSTEM O&S COST REDUCTION

1. Design-Related

a. Army Systems

1) AH-64 Apache Helicopter

The Army's attack helicopter, the Apache, is currently in the early stages of a major upgrade from the original A-model aircraft to a D-model. With this major upgrade, the depth and scope of changes are actually commensurate with a new production program. Additionally, the program has a robust recapitalization program seeking to return the aging carry-over components to a zero-life/like-new condition. Consequently, a major emphasis of O&S Costs reduction is to incorporate design improvements concurrent with the production upgrades and recapitalization efforts (Website, DOD R-TOC). As for O&S Costs drivers, an unusually high percentage of O&S Costs are consolidated in just a few items. Figure 4-8 below indicates that 30% of the total aircraft costs are in a single item (target acquisition system) and 78% of the total aircraft costs are in the top five categories of items.

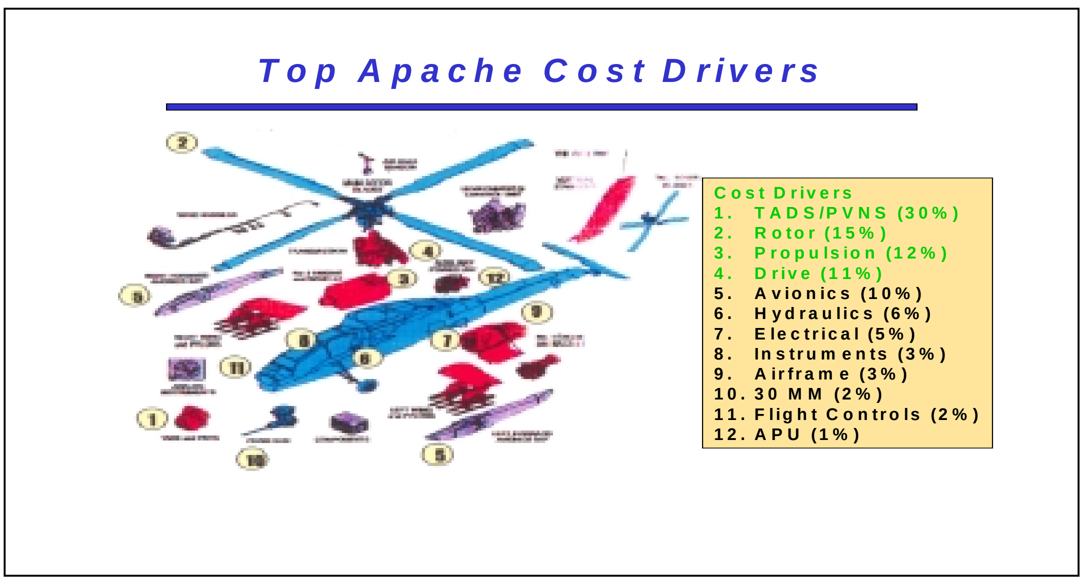

Figure 4-8. Top Apache Cost Drivers

The chief metric for evaluating the impact of these cost drivers is their relationship to the Per Flying Hour Cost of the aircraft. Specific design-related issues with the target acquisition system (top cost driver) include a 25-year-old design, insufficient Built-in Test (BIT), a large number of Line Replaceable Units (26), a large number of overall parts (over 9000), extensive obsolescence issues, the over-all architecture and processing design of the system being “maxed-out”, and a high number of historical engineering changes (450). Horizontal Technology Integration (HTI) initiatives have resulted in an approximately $260M cost avoidance (Nenninger, 2001). Reliability improvements are a key component of the O&S Cost reduction strategy but have encountered problems obtaining sufficient funding. Finally, key maintenance focus areas include reducing the maintenance hours per flight hour, eliminating unscheduled maintenance, and substantially reducing scheduled maintenance (Bosse, 2001). The key design-related lesson learned to date from the R-TOC program is a “clearly articulated set of requirements (Nenniger, 2001)."

2) M-1 Abrams Tank

The Army’s main battle tank has multiple configurations of tanks produced over a long period of time. The principal design-related O&S Cost reduction activities are a major partnership program with industry to overhaul the entire fleet to extend the fleet life by approximately 30 years and the implementation of a technical support program to replace obsolete parts, enhance vehicle safety, and provide post-deployment software support (Website, DOD R-TOC). In particular, the partnership program between Anniston Army Depot and General Dynamics for the system overhaul program has reduced future O&S Costs by as much as 50% through reliability and maintainability opportunities (Matthews, 1999). Specific reliability and maintainability activities include the rebuild of the gas turbine engine, replacement of the original Abrams engine, an contractor-depot innovative overhaul program to original factory standards, a redesign of key turret and hull LRUs, and the incorporation of an embedded diagnostics system (Website, DOD R-TOC). Abrams has also instituted a comprehensive Modernization Through Spares (MTS) program, a Simplified Test Equipment program for an automated test system for vehicle diagnostics, a second-generation Forward

Looking InfraRed (FLIR) sighting system to replace the current system, and a series of other major item modification programs (Website, Abrams Project Office).

3) Crusader Howitzer

The Army's developmental program to field a new self-propelled howitzer system has recently been restructured for consistency with the Objective Force and Army Vision. This system, consisting of three main vehicles, is focusing on design activities to reduce O&S Costs as a flagship program under the Cost As an Independent Variable (CAIV) initiative. Key design activities include open architecture, component commonality, embedded diagnostics/prognostics, system automation, and LRU modularity. Maintainability initiatives include better packaging and cabling of electronic components, changing the level of replacement from large LRUs to circuit cards, increased parts commonality, and improved accessibility. Reliability improvements focus on reducing the number of propellant and projectile carriers, changing the turret traverse concept, and reducing the number of road wheels and support rollers (Website, DOD R-TOC). A key commonality initiative is the use of a slightly-different version of the same engine to be retrofitted to existing Abrams tanks. Of the predicted total O&S Costs for the system, 77% of the costs are expected to be in military and maintenance personnel (See Figure 4-9 below). The design activities are expected to reduce the over-all personnel costs by 13% to 33%. Spare and repair parts are expected to be 13% of the over-all O&S Costs of the system. A single item, the LV-100 engine, is expected to account for 23% of the total parts cost of the system and only 14 items account for 86% of the predicted total parts cost for the system. Crusader is using a variety of R-TOC tools, models, and techniques to make the correct design decisions (Mattingly, 2001).

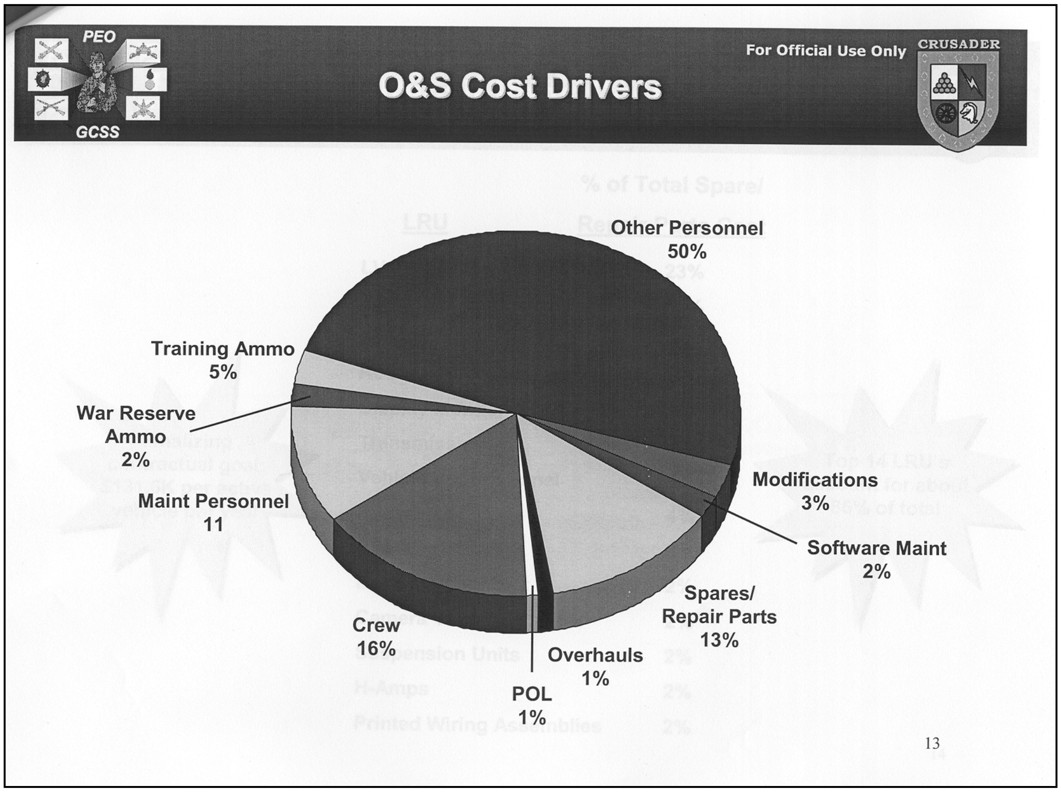

Figure 4-9. Crusader O & S Cost Drivers

4) Multiple Launch Rocket System (MLRS)

The Army's rocket and missile launcher is a fielded system with products in all phases of the life-cycle. The design-related initiatives are focused on the top ten cost drivers. The vehicle's Electronics Unit is being modified by redesigning one of the circuit cards, by incorporating a new relay, and by applying additional vent-cooling value covers. The Fire Control Unit is being modified by six specific Modifications Work Orders (MWOs) to improve reliability. For the mechanical hardware, the transmission has two assemblies being replaced for improved reliability and maintainability. Additionally, numerous MWOs are being applied to the engine, the ball screw actuator assembly, and the elevation transmission. One catalyst for these design-related initiatives is the goal of reducing military personnel O&S Costs. As shown in Figure 4-10, the three top ownership cost drivers are all military pay categories which account for a whooping 74% of ownership cost! Finally, the figure indicates that only

19% of total ownership costs are "manageable by the program office (MLRS Brief, 2000)."

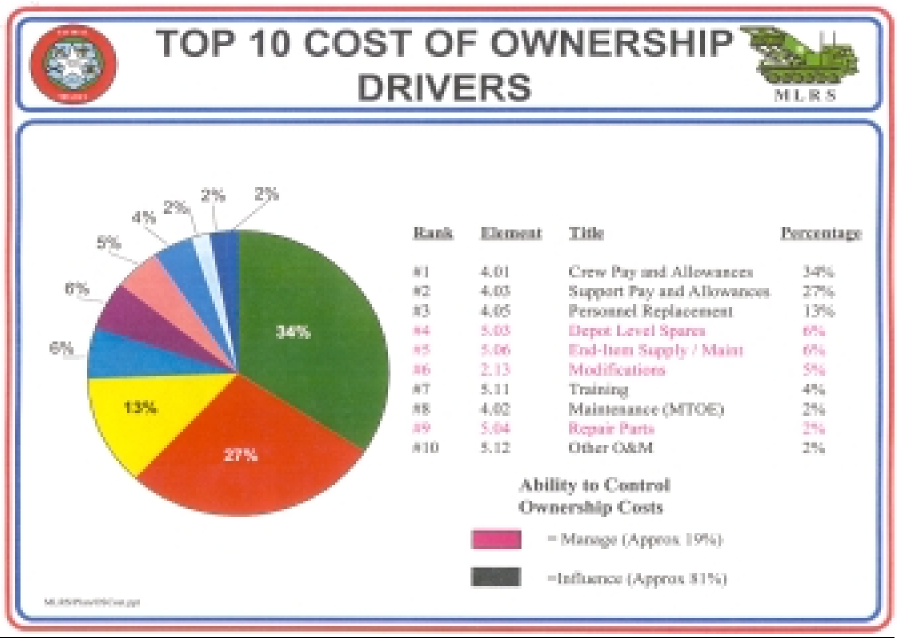

Figure 4-10. Top 10 Costs of Ownership Drivers (MLRS)

b. Air Force Programs

1) B-1 Bomber

The Air Force's long-range strategic bomber has a limited inventory (93 planes) of fielded aircraft. The B-1's design-related O&S Costs reduction efforts center around two major subsystem upgrades (aircraft computer and defense systems) and a variety of reliability and maintainability improvements (Website, DOD R-TOC). The specific R&M initiatives include the elimination of a fuel tank guard requirement, the insertion of a long-life windshield, the upgrade of system & radar test benches, a new digital engine controller, digitized technical orders, and an electrical load upgrade. Finally, the consolidation of LRU repair into one long-term contract will save over $2.2M annually (Miller, 2001).

2) Airborne Warning and Control System (AWACS)

The 33 aircraft in the Air Force's AWACS inventory are modified Boeing 707 commercial aircraft to provide critical surveillance and command & control.

The focal area of design-related O&S Costs reduction efforts are the selective modification and replacement of subsystems (Website, DOD R-TOC). The low-density, but high-OPTEMPO systems have 51% of its total O&S Costs in mission personnel. The three O&S Costs drivers targeted for cost reduction are depot-level reparables, Petroleum/Oil/Lubricants (POL), and overhaul/rework. Two of these three categories are projected to have significant cost growth in future years as shown in Figure 4-11 below. Reliability and maintainability candidates are boost pumps, automatic test equipment, consoles, de-fueling panels, and wiring replacement. Due to the limited density of aircraft, modifications and improvements have marginal return-on-investment savings (Robillard, 2001).

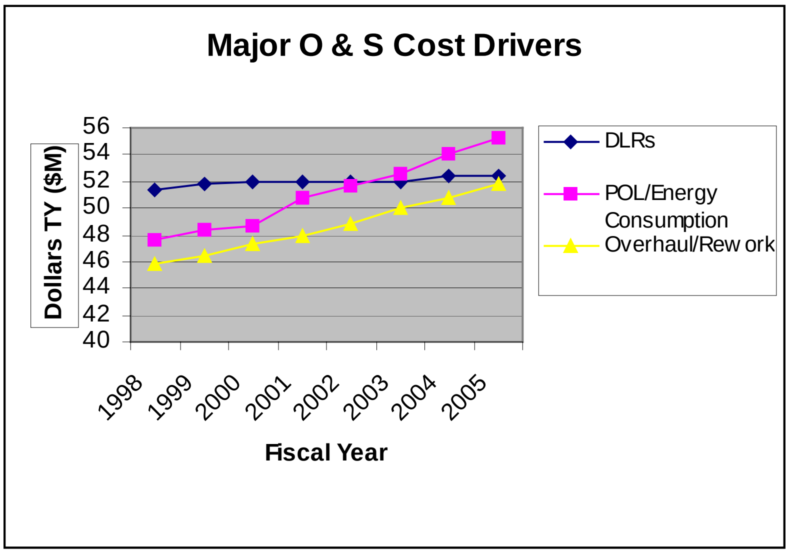

Figure 4-11. Major O & S Cost Drivers (AWACS)

3) F-16 Falcon Aircraft

This multi-role fighter aircraft has been fielded since the late 1970s and has over 3,000 operational aircraft in over 20 nations. The design-related O&S Costs reduction activities are focused on a wide variety of reliability and maintainability improvements to include lightweight wheels and brakes, a heads-up display electronic unit as a Commercial Operations and Support Savings Initiative (COSSI), a maintenance-free battery, a falen modification to prohibit moisture intrusion, and an electronic lubricant for corrosion prevention. Other R&M improvements include a new ring laser

gyro that doubled the previous mean-time-between-failure metric, a hydraulic filter replacement, which increased on-demand maintenance scheduling to every 600 flying hours, and a falcon-flex cable that greatly improved avionics maintainability (Website, DOD R-TOC). The design improvements revolve around a systematic "block" modification strategy, which has involved over 60 major block modification programs over the past 25 years (Website, Military Analysis Network).

4) C-17 Globemaster II Aircraft

The Air Force's newest, most-flexible cargo aircraft's design-related O&S Cost reduction initiatives include a modern intermediate-level test station, a combustion exit temperature kit for the engine, and an optical quick access recorder upgrade (Website, DOD R-TOC). The program had a major emphasis on reliability and maintainability during its design phase which resulted in substantial O&S savings in reduced manpower and spares requirements. The validation of these R&M requirements was one of the programs three critical goals at its milestone review and was accomplished by a rigorous 12 aircraft "up-tempo" exercise for 30 consecutive days. Figure 4-12 below summarizes the reliability and maintainability achievements (Davis, 1997). A General Accounting Office (GAO) report confirmed that the aircraft met or exceeded 10 of the 11 requirements, but that the evaluation was less demanding than originally planned. The one requirement, which was not met, was "built-in test parameters (Report, GAO #96-127, 1996)." One of the major lessons learned from the program for future acquisitions was the criticality of designing the system with the "flexibility to grow and adapt via an open system architecture (Kennedy, 1999)."

Parameter	Actual Percent	Req. Percent	What's Good
On-time departure reliability	99.20	n/a	n/a
Mission completion success probability (MCSP)	97.50	86.00	Higher
Mean time between maintenance (inherent) MTBM(I)	3.94	1.31	Higher
Mean time between maintenance [corrective] MTBM(C)	1.81	0.63	Higher
Mean time between removal (MTBR)	8.47	2.26	Higher
Maintenance man hours per flight hour (MMH/FH)	3.45	27.7	Lower
Mean man hours to repair (MMTR)	2.50	8.16	Lower
Mission capable (MC) rate	90.70	80.80	Higher
Fully mission capable (FMC) rate	85.10	73.00	Higher

Note: Requirements and goals above are based on growth curves leading to mature values.

1. RM&AE numbers based on 15,000 hr (est).
2. Mature numbers based on 100,000 hr.

Figure 4-12. Reliability & Maintainability Achievements (C-17 Aircraft)

c. Navy & Marine Corps Programs

1) CVN-68 Aircraft Carrier

As the largest warships in the world, the nine nuclear carriers have a service life of 50 years and an annual unit operating cost of approximately $160M! The ongoing design-related initiatives are focused on reliability and maintainability improvements and include improved composite materials, commercial air compressors, transient voltage suppressors, ventilation moisture separators, and improving materials to reduce maintenance costs. R&M actions are typically performed as scheduled "block" modification activities (Website, DOD R-TOC). Additional unique initiatives such as Engineering for Reduced Maintenance, Technology Back Fit, Cumbersome Work Practices Analysis, and Smart Carrier Initiatives, focus on reductions in military personnel accounts, particularly in maintenance costs and crew workload (Report, GAO to Senate, 2001).

2) Advanced Amphibious Assault Vehicle (AAAV)

The armored Marine Corps personnel carrier has been one of DOD's most successful programs in reducing O&S Costs via innovative design activities in its developmental phase. The system's "virtual prototype" and " simulation design approach" allowed numerous initiatives to be tested, refined, and proven to a high-degree of design maturity before expensive full-scale development was initiated (Website,

Department of Navy, Best Practices). General design-related improvements were reliability and maintainability improvements in the engine's design, common ammunition, a "unique spray-cooling" chassis, and the mandate of a two-level maintenance concept (Website, DOD R-TOC). Specifically, the program required the contractor to adhere to innovative design rules such as limiting on-board tools, requiring specific maintenance accessibility, controlling maintenance interfaces, designing LRU's for replacement in uncontrolled environments, and quantifying operator/maintainer abilities to perform tasks to 90% accuracy one-month after initial training. Other O&S improvements included embedded training, interactive electronic technical manuals, extensive built-in test, partitioning of LRUs based on function/interconnectivity/skills, and the use of commercial off-the-shelf hardware and other non-developmental items (Website, AAAV Program Office).

3) LPD-17 Amphibious Transport Ship

The Navy's new transport ship, currently in the development phase, will replace four existing classes of amphibious ships. The first ship will be delivered in FY 03 and have a 40-year service life (Website, DOD R-TOC). The system's principal life-cycle O&S Costs drivers are manpower (39%) and maintenance (32%). These two areas are being attacked through integrated product teams using a host of modeling and simulation tools (Association of Scientists and Engineers, 1998). The approach to reducing these two cost-drivers covers a wide variety of activities, which include policy changes to achieve space and manpower efficiencies, the reduction in over-all maintenance workload, the implementation of new technologies to reduce the demand for maintenance, and ship departmental reorganizations (Final Systems Engineering Report, 1997). The program's specific design-related O&S Costs reduction efforts are primarily reliability & maintainability initiatives such as an Advanced Enclosed Mast System with improved reliability, reduced sensor maintenance, an open architecture for future upgrades, improved coatings for corrosion control, improved food service, new emergency automatic lighting systems that incorporates better batteries, and the reduction of Government-furnished equipment (Website, DOD R-TOC). To date, the initiatives

have collectively achieved an estimated $4.3 billion life cycle cost avoidance out of a $5.2 billion goal (Report, GAO to Senate, 2001).

4) H-60 Helicopters

The H-60 program is a consolidation of three in-service helicopter programs with a major emphasis on remanufacturing, service-life extensions, and new production to create a total fleet of 500 helicopters (Website, DOD R-TOC). The program's design-related O&S Costs reduction efforts are focused on reliability, maintainability, availability, and safety. Specific efforts include an increase in dynamic component life limits, the development of an Integrated Individual Aircraft Fatigue Tracking System, improved batteries, additional test sets, a common cockpit, a value-engineered mission computer, and a Health Usage Monitoring Systems (Husaim, 2001). Other O&S initiatives are the reduction in the number of configurations to support, utilizing remanufacture to increase reliability and maintainability characteristics of LRU's, and utilizing recapitalization programs to decrease the demand for scheduled maintenance (Report, GAO to Senate, 2001).

2. Plan-Related

a. Army Systems

1) AH-64 Apache Helicopter

This program has pursued a Prime Vendor Support (PVS) approach whereby the prime contractor (Boeing) would "assume total responsibility (nose-to-tail) for the wholesale support of the Apache helicopter, which includes availability guarantees, modernizes the aircraft through spare parts, and partners with the Army depots." However, PVS for Apache was terminated in November 2000 (Nenninger, 2001) due to unresolved Army Working Capital Fund (AWCF) issues. With the fielding of the D-Model aircraft, the maintenance concept is being changed from the current three to two levels of maintenance, more LRUs are being replaced at the unit level, training devices are being substantially improved, integrated electronic technical manuals are being fielded, and spares management is being improved via single asset managers (Website, DOD R-TOC).

2) M-1 Abrams Tank

The Abrams program is implementing a Performance-Based Field Logistic Support program consisting of a Government/industry partnership to provide configuration-unique support via repair, upgrade, and storage of spares and components. The partnership arrangement provides for a reduced surcharge and a streamlined order-delivery management system. Abrams is expanding the use of prime contractor support for depot-level repair of unique parts. The program has been selected as one of four pilot programs to experiment with establishing formal performance agreements with the warfighter based on availability and readiness needs, the use of contracts with organic suppliers for output and availability, and the use of a program-specific working capital fund to pool funding sources in order to provide a robust financial base for the project manager (Website, DOD R-TOC).

3) Crusader Howitzer

The program's plan-related activities are to develop a life-cycle support system that integrates Government and industry sources for sustainment products and Services, that capitalizes on commercial best practices and technology advances, and integrates all elements of logistics support to provide optimal, cost-effective sustainment options (Website, DOD R-TOC)." A maintenance concept is planned that requires an open architecture for modernization through spares activities and other modular improvements (Mattingly, 2001).

4) Multiple Launch Rocket System

This program has developed a teaming approach with all "stakeholders" in ownership cost reduction to include the combat developer, Field Artillery schoolhouse, the Service materiel command, and all of the major contractors and vendors. In addition to the normal O&S Costs reduction efforts of system improvements, an Integrated Product Team (IPT), chaired by the PM, is comprehensively addressing all areas in which O&S Costs may be reduced to include organizational changes, a team business approach between the prime contractor and project office, completely overhauling the sustainment process through which MLRS is sustained, and contracting-out logistics support and Services. Since the system's O&S Costs are

predominately in military pay accounts, the system is considering major structural changes to business practices. These changes include workarounds with the Army Working Capital Fund (AWCF), control of O&S funding to include reprogramming authority, and relief from public laws dealing with the 50-50 contractor vs. organic core workload and waivers for A-76 privatization initiatives (MLRS Brief, 2000).

b. Air Force Systems

1) B-1 Bomber

The fielded system is reducing the total fleet by approximately one-third and consolidating the aircraft at two bases to reduce the ownership costs. The program is digitizing technical/maintenance procedures to more efficiently perform maintenance and make changes (Miller, 2001). Service-level agreements with organic supply managers have been established to improve logistics response times. Maintenance task intervals for some pieces of hardware are being extended. Lifetime contractor repair arrangements are being re-negotiated to consolidate the repair of sets of Line Replaceable Units (LRUs) (Website, DOD R-TOC).

2) AWACS Aircraft

The program is using block upgrades, managed and implemented by the prime contractor, to expand the user-contractor partnership. AWACS is increasing contractor weapon system responsibility via a planned single, overarching system support contract (Website, DOD R-TOC). The program office is considering a Program Depot Maintenance (PDM) partnering agreement, actively seeking more subcontractor involvement, and evaluating the allocation of maintenance tasks between depot and field levels. Finally, the program is wrestling with the dilemma of contracting for support when most of its prime mission equipment is "militarized" with very little commercial-off-the-shelf hardware (Robillard, 2001).

3) F-16 Falcon Aircraft

This program in pursuing a Combined Life-Time Support Program with industry to partner for product support. The production and spares contracts have incentives for contractors and vendors to build more reliable parts. Technical and maintenance procedures are being digitized for more efficient use. Support equipment is

being made more common to accommodate standardization needs, diminishing manufacturing sources, and obsolescence. Process improvements are being implemented to improve workload disbursement, parts availability, and maintenance scheduling. Finally, the program is “examining the potential of Reliability Centered Maintenance (Website, DOD R-TOC)."

4) C-17 Globemaster II Aircraft

The C-17 program is implementing a total weapon system readiness responsibility arrangement with the prime contractor. A single-point manager is responsible for integrating all spare parts issues, including non-inventory-control-point parts, with other Government agencies. C-17 has procured a commercial data system for total asset visibility. The program office is pursing a Flexible Sustainment Strategy contract on a trial basis. This performance-based contract measures key system-level metrics as future evaluation criteria when deciding on whether permanent depot-level support will be organic or contract (Website, DOD R-TOC). Finally, a Government report asserts that the Air Force paid significantly higher prices for spare parts when the prime contractor decided to produce the parts in-house rather than purchase the parts from outside vendors (Report, GAO #96-48).

c. Navy & Marine Corps Programs

1) CVN-68 Aircraft Carrier

The Navy's plans for reducing O&S Costs on the carriers are activities, which reduce response times, require less spares, and have a reduced logistics footprint. The possibility of competitive sourcing is identified as a “to be determined initiative (Website, DOD R-TOC)."

2) AAAV Vehicle

As a developmental system, AAAV is conducting a variety of supportability assessments to determine the specific supportability strategy to include the sources of supply and contractor logistics support (Website, DOD R-TOC). Training and training support is considered the program's "most futuristic logistics initiative” which consists of extensive embedded training, a Distributive Interactive Simulation (DIS) environment that allows the Marines to participate in integrated mission rehearsals with

air and ship support, and an integrating Interactive Courseware System (ICS). Additionally, the training program provides gunnery, navigation, and driver training at the units and with deployed forces. To foster real change, the project office employed "user juries" during the developmental program to advise and accept/reject ideas (Website, AAAV Program Office). As one of the most unique initiatives in current acquisition practices, the program collocated the program office with the prime contractor and major subcontractors to maximize management effectiveness and efficiency and believes that "collocation has been a key to their success (Website, Department of Navy, Best Practices)." The system utilizes a significant degree of commercial-off-the-shelf hardware and non-developmental items (Website, PM AAAV, 2001).

3) LPD-17 Amphibious Transport Ship

The developmental program is pursuing a Full Service Contracting (FSC) strategy whereby a single team is responsible for the complete design, construction, and critical life-cycle support functions for the entire ship class over its operational life. The strategy includes a radical tactic of reducing (and possibly eliminating) Government-Furnished Equipment (Holser, 2001). A Best Value Team has been established and is using a formalized tool to objectively determine the detail support strategy as an Integrated Product and Process Development (Association of Scientists and Engineers, 1998). To support this life-cycle support goal, General Dynamics has enhanced its Bath Iron Works shipyard to offer fleet Services, integrated logistics support (all elements), post-deployment engineering, configuration management, operational cycle management, and other O&S functions in order to provide a complete post-production support capability for ships (Website, General Dynamics).

4) H-60 Helicopter

The helicopter program is pursuing a variety of initiatives and plans to reduce O&S Costs. An integrated maintenance concept is being implemented to consolidate the various maintenance concepts of the three similar aircraft models and configurations into one maintenance concept. Direct-vendor delivery contracts are being established and parts tracking systems are being implemented to improve logistics response times (Website, DOD R-TOC). Contractor long-term logistics contracts are

being awarded to execute performance-based requirements. A pilot program of allowing the project office to re-invest 70% of achieved O&S savings into additional improvements is also being pursued (Husaim, 2001).

E. CHIEF LOGISTICIAN'S ROLE

The typical chief Logistician in a developmental program office faces formidable challenges in reducing O&S Costs. As indicated in the previous data, this person has major policy obstacles to address, a wide variety of general logistics initiatives to accommodate, and a unique set of issues within his or her specific weapon system that must be resolved. Given this environment, the following data discusses three basic roles that the Chief Logistician must play.

1. Cultural Role

The logistician continues to suffer from cultural impediments within the general acquisition community. Program offices "strive to spend less on logistics. Engineers are cranking out changes faster than the logistics systems can install or support them where the Program Manager can't pay for them (Eaton, 2000)." Technical performance and cost goals and activities dwarf those of logistics. The logistician's chief concern, the cost of the logistics tail once the item has been fielded, is a minor concern to the design engineer and is "dutifully reported as a result of design," not a criteria of design (McIlvaine, 2000). Logisticians often appear to be outside the acquisition world while those on the inside are "disrupting logistics at worst and sub-optimizing life-cycle support at best (Eaton, 2000)." Many times, the measure of the logistician's worth is dealing with shortsighted design decisions and keeping systems in the field no matter how good or bad (McIlvaine, 2000).

2. Program Role

The general perspective on the importance of logistics as a critical factor in determining the program's success continues to lag in importance. In a recent survey concerning "program success indicators," Project Managers ranked "meeting logistics supportability objectives" as least important of 5 major success indicators (Delano, 1998). The program office logistics/support office typically has smaller numbers of people, at a lower grade structure, with proportionally less funding, and at a physical

location removed from the mainstream of the project office. From a simple listing on the organizational chart to the ranking of divisional inputs into key programmatic decisions, the logistician seems to consistently be placed last in the proverbial program office pecking order. Regardless of these pitfalls, the critical success factors for a typical Governmental program seem to directly relate to the same roles that the logisticians needs to fulfill in the typical program office. A recent study indicated that the top five critical success factors for a project office were, in order, “continuous meaningful visibility using measures, stable and adequate funding, leadership, clearly defined and stable requirements, and a technically-competent program office staff (Dobbins, 1998)."

3. Occupational Role

Generally, logisticians are developed from the two general career sources: maintenance and supply support. Each of these two career fields has a distinctly different career path. Maintenance, typically a GS-1670 Equipment Specialist career field, focuses on the technical aspects of maintainability engineering, maintenance planning, new equipment training, and maintenance publication development. Currently, supply support, typically a GS-2010 Inventory Management career field, focuses on the inventory management of items to include requirements determination, major & secondary item management, procurement, and depot workloading. While several other career fields are involved in general logistics management, these two fields represent the backbone of the historical occupational development of personnel staffing acquisition logistics positions in program offices. The typical logistician working in the advanced areas of acquisition logistics are in the General Schedule (GS) Classification 346: Logistics Management Specialist. Since the GS-346 field is in the administrative section of occupational classifications, some view this classification as a “serious disconnect” by not making a logistician an "occupational professional" (Eaton, 2000). On a positive note, the person involved in acquisition logistics has a defined career path within the acquisition workforce. The highest level of certification requires four years of acquisition experience (with four additional years desired), a desired master’s degree in a technical/scientific/managerial field, and a required combination of intermediate and advanced training courses (DOD Directive 5000.52-M, 1995). As a result of this

directive, most senior logisticians matrixed to the PM's office are members of the Army Acquisition Corps (AAC) and are certified at the highest level (Level III). Logisticians can earn a Certified Professional Logistician (CPL) designation through the International Society of Logistics Engineers (SOLE) by passing an extensive examination in the general areas of “systems management, system design and development, acquisition and production support, and distribution and customer support." Currently, fewer than 2,500 logisticians worldwide have attained the CPL designation (Bates, 2001).

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IV. ANALYSIS

A. OVERVIEW

The following analysis surveys the entire landscape of data from the previous chapter to identify and discuss a distinct and insightful set of observations concerning the key roles and strategic imperatives of Chief Logisticians in reducing O&S Costs in developmental programs. These key roles are organized into analytical sections that directly relate to the secondary research questions. These analyses do not repeat the obvious "textbook-type" revelations of the sources of O&S Costs growth. The basics of O&S Costs reduction are fairly well documented. Rather, this analysis seeks to capture common trends and patterns that reveal the real keys to understanding how excessive O&S Costs are actually reduced and prevented during developmental programs.

B. STRATEGIC IMPERATIVES

1. Criticality of Timing

The decision to not be involved at the “right time” in the system acquisition process may the single greatest mistake in reducing O&S Costs. The life-cycle cost commitment model (Figure 4-1) is the central revelation in this “timing” issue. Although universally accepted as a factual model, the model’s implications have essentially been disregarded over the previous decades (assuming the acquisition community was genuinely interested in O&S Costs reduction). The model indicates that by Milestone III (now Milestone C), entry into full-scale production, essentially 95% of the system’s “life-cycle costs are committed” although only about “10% of the life-cycle cost are actually expended.” The basic point, as related to this Thesis, is that ***previous decisions have collectively determined future costs, regardless of what is being done in the present.*** Given that most life-cycle costs are in the O&S area and that these O&S Costs occur after Milestone III, then its logical to conclude that O&S Costs are “already pre-determined” prior to their actual occurrence. I’ll refer to this revelation as ***the “Law of Pre-destination of O&S”*** which is fully explained in succeeding paragraphs.

2. Law of Predestination of O&S Costs

The term “pre-destination” is a powerful term with profound consequences. What the term implies is that you can do little, or nothing, to change the course of events once a

key decision or collection of decisions are made. The term is often used in explain the Calvinist view of theology in which decisions made in the past determine the future regardless of what we do in the present. The life-cycle model's implications and the crux of the research that I've conducted indicate that the pre-destination is directly application to the strategic reduction of O&S Costs. Once key decisions are made early in the life of the program, the logistician can do very little to actually substantially change the course of future O&S Costs. This is supported by the discovery that essentially two-thirds of all O&S Costs initiatives identified in the research of fielded systems are actually just corrective actions of "bad" decisions made early in development. While this timing issue will be explored further in future analysis, three general points need to made about the criticality of timing in order to avoid the inevitable consequences of the pre-destination.

a. Any time… after the Beginning…is Too Late

Pre-destination occurs at an ***exponential rate*** during the ***conception*** of the program. According to the model, approximately 70% of life-cycle cost is pre-determined by Milestone I (initiation of the demonstration/validation phase). Most of the 70% occurs in the earliest stage of the period between Milestone Zero and One. Consequently, the logistician's principal ability to really impact O&S Costs are a direct function of decisions made long before the system even enters the demonstration/validation phase. The emphasis is on "before" development; not "during" development. Much of the literature today argues for the logistician to be an active partner with the concurrent engineering team as the principal methodology for insuring future O&S Costs are minimized. The data indicates that even this "developmental involvement" is too late. The largest percentage of O&S Costs are determined during the ***conceptual phase*** when ***requirements and specifications are being defined*** and ***not when logistics considerations are being designed*** into the system! Unfortunately, in many instances, the quantitative effort of these deficiencies can only be defined once the system is fielded and supported. The specific requirements and specification activities that the logistician should be involved in will be explored later.

b. Participant vs. Spectator/Consultant

The logistician's early involvement should be as a participant and not as a spectator or consultant: Presence is not participation. A general analysis of the data indicates that many programs are in a mode of correcting fundamental flaws in the logistics-compatibility of the hardware design or fundamental defects in the structure of the logistics support system. Collectively, these two flaws of design and planning ultimately predestine whether or not future O&S Costs will be reasonable or excessive. The evidence points toward the general lack of participatory involvement by highly experienced, professional logisticians who have the skills to avoid major supportability mistakes during the conceptual phase. The data seems to suggest the following typical scenario:

> ***An Advanced Concept and Technology Demonstration (ACTD) or "advanced concept" program in one of the Service's research and engineering centers is being formulated with an immature requirements document on an austere budget. The leader contacts the loggies just to make sure their in-the-loop so he can check the coordination block in a program status report or briefing slide. The logistics organization assigns a single generalist or staffer to attend meetings and provide input when asked (spectator/consultant). A couple of years "rocks" along, the program passes the point where 70% of the life-cycle cost is already predestined, the program "enters validation/demonstration" and a Chief Logistician and a couple of other logisticians, who don't realize that most of their latitude to substantially influence costs has already passed, are hired to "concurrently engineer" the system for supportability during the development phase.***

Consequently, in a manner similar to how a Calvinist adapts his behavior to be consistent with his theology, a logistician must adapt his behavior to be consistent with the revelation of the Law of Pre-destination of O&S Costs. The logistician must be a Genesis 1:1 participant who's future commendation should read…. "In the ***beginning***, this logistician helped ***create*** a design and support system that optimized logistics support while minimizing life-cycle costs." The key words are "beginning" and "create" and it

results from early participation, (not consultation) and involves creating (not reacting to) a logistics support system. The logistics participants should be a highly-technical and seasoned team of logisticians with excellent maintainability engineering & planning skills. A complete analysis of these needed skills will be explored in future paragraphs. .

c. Persistent Proactivity

The Chief Logistician must be highly proactive in diplomatically involving himself in the new-start activity while not being guilty of "Crashing the Party" or "Waiting for an Invitation." Since logisticians are generally last on the list of Who's Who in assembling a new-start team, the logistician genuinely desiring to do the right thing faces a formidable obstacle in gaining the needed participatory status. Again, timing is everything. If the invitation is too late (the usual norm), then the logistician cannot substantially affect the outcome. If the logistician crashes the party, he risks alienation from the allies he desperately needs. The leadership of the logistics organization must be cognizant of all new-start activity and ensure that the program leadership has logistics involvement during the conception of the program. Being specifically invited to participate establishes the authority and credibility that is critically needed at this point of maximum pre-destination.

3. Develop Realistic Expectations

This law of pre-destination has a major implication for reducing ownership and O&S Costs in today's environment dominated by fielded weapon systems: Adjust expectations based on the weapon system life-cycle phase. Recognize the inertia of the Law of Predestination of O&S Costs. If your system is in production or is fielded, bonafide major reductions of ownership costs should not be expected. When reviewing the data of new O&S Costs reduction achievements for fielded systems, the list of achievements are short in number and low on cost savings. Many are merely rectifying previous design or planning mistakes and claiming the corrective actions as a success in ownership cost reduction. Correcting past mistakes are not really bonafide O&S improvements; they're an expenditure of additional dollars to correct a flaw that should have been prevented. Sadly, this is the point where most of DOD is trending water today.

Major emphasis on ownership and O&S Costs reduction has met with limited success. Great intentions but the gods of O&S pre-destination have thwarted their good works.

4. Overcoming the Law of Pre-destination of O&S Costs

The data indicates that the Law of Pre-destination of O&S Costs can be overcome under one general approach. Interestingly, this approach is simply a reincarnation of the model at a different level. When reviewing the limited number of success stories where significant O&S reductions have been made on fielded systems, the common denominator is that they re-designed the system or support structure. Reliability and maintainability design changes, at a sub-system level, are by far the most common design initiatives to reduce O&S Costs for fielded systems and are often executed by "block modifications." Effectively, these design changes return the clock of the life-cycle commitment model back to near-zero. Future life-cycle costs are pre-determined during the conceptual phase as an engineering change. Consequently, the Law of Predestination is still in-effect, but at a lower-level via a modification activity. Now, since the system is fielded and an adequate logistics staff is ready, willing, and able, logistics requirements have top-billing and good supportability decisions are usually made to pre-determine future costs. However, the effect of these reincarnation efforts at a lower-level do not appear to have the same patterns of "commitment of life-cycle cost" and "life-cycle costs actually expended" as listed in the original model. Because of the cost of changing fielded hardware, the data suggests that the "gap" between the curves compresses considerably. More life-cycle costs are expended at an earlier time frame (due to investment requirements) and the escalation rate of the upper curve (life-cycle cost commitment) is lower (due to lower impacts of decisions made). Still, the Law of Predestination can be overcome on fielded systems by making sub-system design changes with proven returns-on-investment.

5. Recognition that Choices have Consequences

The fundamental reason we have an inventory of weapon system's with excessive O&S Costs is that we made a conscious decision to do so. Excessive O&S Costs didn't evolve from the primordial soup of materiel acquisition; they were created by conscious choices made by acquisition officials during the early stages of the program. Most of the

fielded systems today were developed and produced in an environment where supportability issues were systematically given a lower priority than technical performance, cost, or schedule. Logisticians were outside the sequential engineering process and operated in the reactive and corrective modes. Logistics resources were consistently robbed to pay for cost over-runs experienced while achieving technical performance objectives. Supportability tasks and needs were routinely traded-off or postponed due to seemingly more urgent priorities. Since the severity of future events (support) could easily be manipulated through optimistic cost estimating, acquisition officials could conveniently justify the present prioritization of development and production. "Let's just built a lot of these things that work well and we'll figure-out how to support it later." Many naively believed that the times of plentiful procurement funding would carry-over into the supportability phase and the perpetual flow of new money would eventually solve the logistics woes. The net consequence of these past choices are weapon systems whose ownership cost is substantially greater that it should be. Tragically, as other analysis in this Thesis will show, due to the criticality of timing in the strategic reduction of ownership costs, it's really too late to efficiently remedy these past practices. We are stuck with excessive ownership costs on most fielded systems. The seasoned logistician can now say: "I told you so." Those who made these choices two decades ago are without excuse. The logistical consequences of these practices were well-documented in the past. The decision-makers choose technical performance and its cost at the expense of support and we must now learn how to deal with the consequences. The principal lesson learned is to not repeat the same strategic mistakes on new-start systems.

6. Ensure Adequate Logistics Weight in Source Selection Criteria

Some of the defects in the logistics design and support structure of the studied systems indicate that logistics carried little significance in the over-all weighting of the source selection criteria when the original prime contractor was chosen. Technical performance criteria were weighted so heavily that the source selected which was the one which optimized system performance at the expense of supportability. Consequently, contractors were "rewarded" for sacrificing logistics considerations based on what the

Government defined as the most important performance and cost characteristics in the original selection criteria. An interesting historical study would be to compare the logistics weighing in source selection criteria of currently fielded major systems to the rate of current O&S expenditures. This author predicts that the fundamental conclusion would be that "we've got exactly what we choose"…excessive O&S Costs. Finally, this analysis indicates that the Chief Logistician must maintain a balanced and reasonable perspective on the role of the prime contractor. The contractor is in business to make a profit consistent with the American free-enterprise system. The logistician's challenge is to ensure that this profit role is directly correlated to key logistics design factors with the appropriate incentives to achieve these goals. If the contractor achieves high supportability objectives, then the contract should adequately reward the contractor with higher profitability.

C. DESIGN ROLES

1. Logistics Engineers as Active Participants in the System Engineering Process

The absolute prerequisite for achieving a logistics-friendly design is for the logistics engineer to be an active participant in the over-all system engineering process. Logistics engineers must first be qualified to participate (covered in another section of this analysis). Given qualified logistics engineers, the person must be fully engaged in the systems engineering process with the skill to satisfy all of the logistics requirements through design activities, the diplomacy to resolve numerous trade-offs that are an inevitable part of any program, and the vision to articulate the cause and effect relationships of design options to future execution of the support system. The critical processes and maintenance planning sections of the research collaborate these inter-related roles and point toward a needed improved stature of the Chief Logistician in the PM team, particularly in terms of technical competence.

2. Role of "Definition" instead of "Influence"

The thrust of academic literature identifies the logistician's principal role as one of "influencing design" for supportability. The data indicates that this "influencing" role has failed to accomplish it's intended objectives. The underlying reason our track record for supportability design is so poor is that we have been "attempting to influence" when

we should be "striving to define". This subtle difference is more than semantics; it is a cultural change in the way a logistician should behave in the acquisition community. The ability to influence is directly proportional to the individual's position, status, or prestige. Unfortunately, since the logistician has historically not possessed as high a position, status, or prestige as the other more-prominent members of the acquisition populous, it is no surprise that low influence has resulted in low accomplishments. Changing the logistician's status to a definition role where he can precisely prescribe the supportability specifications is a key choice for the acquisition leadership. Without this cultural change in the logistician's position, an influence-only role will only perpetuate sub-par performance. The specific characteristics of this needed "definition role" will be analyzed in another section.

3. Preeminence of Support "Requirements"

Although "design" seems to receive top-billing as the single most important task for logisticians, the data indicates that "requirements" must be the preeminent function of the logistics community if they are to strategically reduce ownership costs. In the acquisition world, the design is a function of the requirement. Consequently, the fundamental way that a logistician defines the design characteristics is through establishing the necessary logistics requirements. The gut reaction to this point by the acquisition community is that requirements are the combat developer's responsibility and not the materiel developer's. Partially true. The materiel developer has the responsibility to ensure that the combat developer includes reasonable, achievable, sensible, and affordable requirements. From the data, it appears that logisticians have not been successful in incorporating logistics requirements into requirements documentation. If they had been successful, the design would reflect the requirements. From a quick review of specific systems, the principal problems appear to be following:

a. Insufficient Numbers of Requirements

Many systems tend to have only a handful of basic logistics requirements. A few Mean-Times (between failure/to repair/between maintenance actions), a Bit-Effectiveness measure, and maybe a transportability measure are the typical number of limited measures of supportability design. Although requirements

should be tailored to the specific system and should be fully justified, the data suggests that excessive O&S Costs are occurring because the non-existent requirement failed to drive the necessary logistical-efficient design. Requirements documents for major systems should contain an extensive list of supportability design requirements. In many cases, the requirements author may not have the expertise to know what logistics requirements are necessary and how to express those requirements with specific terms. The Chief Logistician in the materiel developer world must identify these deficiencies and convince the combat developer to include the proper number of logistics requirements.

b. Measurable Requirements

The data suggests that many logistics needs are not met because the requirement was expressed in qualitative and not quantitative terms. "Optimizing, maximizing, or minimizing" a specific design feature is an exercise in relativity in which the nebulous design characteristic can easily be lost in significance to quantifiable performance criteria. The qualitative terms are too common in logistics requirements documents. With the advent of performance specifications, the definition of logistics requirements has become more difficult since they must often be measured in the dynamic environment of operations and support.

c. Defendable Requirements

Possibly the underlying reason that logistics requirements are so scarce is that they cannot be defended and are scratched from the requirements documentation. The well-intentioned, but many times ill-equipped, author of logistics requirements must be capable of discriminating between requirements and preferences, estimating the influence the requirement has on future logistics efficiency and effectiveness, and negotiating trade-offs with other competing needs of the program.

d. Critical Requirements

Identifying a core group of critical logistics requirements is impossible to define since one-shoe-doesn't-fit all systems. However, from the research,

the following requirements consistently appear and should form a core group of critical requirements for most logistics programs.

Built-in Test Effectiveness	Mean Time To Restore System
Direct Man-Hours Per Maintenance Action	Mission Reliability
False Alarm Rate	Operational Availability
Fault Isolation	Reliability Growth
Inherent Availability	Service Life
Integrated Diagnostics	Software Error Rate
Maintenance Event Time	Software Maintainability
Mean Time Between Failure	Stock Availability
Mean Time to Repair	Turnaround Time

4. Stroking the King and Queen of Supportability Design

Numerous supportability design requirements are important. However, the undisputed king and queen of supportability design areas are reliability and maintainability, respectively. Of the more than 100 initiatives noted for the 12 researched systems, approximately 65% of those initiatives were either reliability or maintainability initiatives.

a. Reliability

As the king of supportability design, reliability fundamentally determines the demand for logistics. With high reliability, there is little demand for logistics. Conversely, with low reliability, the demand for logistics increases exponentially. Unfortunately, reliability is not directly a domain of the logistician's responsibility. Consequently, the very item that most dramatically affects the demand for logistics is not even under the control of person it most affects. Therefore, logistics engineers must partner with their counterparts in reliability engineering and collectively define and allocate reliability requirements affecting logistics throughout the system. From the data, it appears that many systems limited the definition of reliability requirements at too high a level and did not allocate down to the maintenance-significant items. All items replaceable at levels above depot maintenance should have a Mean-Time-Between-Failure (MTBF) requirement. Additionally, the logistician must lobby the reliability community to invest in ultra-reliable technology. One of the key goals of the logistics

community should be the development of such highly-reliable items that the Level of Repair Analysis (LORA) should conclude it is more cost-effective to discard the item on its rare failure than to construct a logistics tail to support the item. The ultra-reliability initiatives (e.g., nano-technologies, microelectronics, biometrics) have great potential to reduce or eliminate the demand for logistics and the corresponding reductions in ownership costs. Finally, the research indicates that reliability efforts should focus on a core group of items. Seven of the 12 systems studied indicated that 60% to 70% of total O&S Costs are attributable to six to 12 key items.

b. Maintainability

As the queen of supportability design, maintainability fundamentally determines the ability to perform logistics. While reliability determines frequency, maintainability determines capability. From a review of maintenance activities in the studied systems, maintainability design characteristics appear marginal. Mediocre testability, modularity, and lack of interchangeability are frequently mentioned symptoms of the real root cause: a marginal maintainability design. For the logistics engineer, maintainability presents another dilemma in responsibility. As a move to consolidate the Reliability, Availability, and Maintainability (RAM) functions into one focal group, many reliability organizations (located in the Research, Development, & Engineering Center) have the fundamental responsibility of maintainability engineering. These RAM organizations have limited logistics skills and logistical knowledge and seem to spend 90% of their time on reliability and the balance on availability and maintainability. Under this scenario and similar to the reliability responsibilities mentioned previously, the logistics engineer may be in the same predicament of not being directly responsible for a critical activity. The maintenance engineering area in the commodity command's logistics center must be very proactive in fulfilling this engineering void.

5. Design for Maintainability

The thrust of the logistics engineer’s effort should be focused on designing the system for maintainability. While other logistics disciplines are very important in the logistical engineering effort (e.g., human factors, transportability, interchangeability),

designing the system for maintainability is the actual beginning point in creating a logistics-effective design. The key decisions in this process are as follows:

a. An Open System Architecture

The current buzz-phrase of weapon system design involves designing the system to readily accept hardware and software changes. All eight of the fielded systems studied mentioned at least one maintainability problem, which was difficult to correct due to architectural-design problems. Most fundamental maintainability problems, particularly in the area of modifications, are directly attributable to the lack of a fluid open system architecture. This concept of an open approach to the system architecture is absolutely necessary to executing future maintainability and modification improvements in that it simplifies the interfaces, integration, and application of Line Replacement Unit (LRU) changes, particularly Horizontal Technology Insertion (HTI) and Modernization Through Spares (MTS) initiatives. Open architecture is being practiced on most of the new weapons programs. All four developmental systems studied in this Thesis are pursuing an open-architecture design.

b. Modularity and Accessibility

Closely aligned to an open systems architecture is modularity, the degree to which items can to interchanged at various levels of support. This generic term may be the single most influential factor in maintainability design. All 12 systems studied mentioned modularity as either an inhibitor to effective maintenance (fielded systems) or as a key design goal (developmental systems). Modularity creates the ability to perform maintenance and repair by allowing simplified assembly, disassembly, and exchange. Modularity is the principal catalyst for allowing most modification activities to execute efficiently, particularly for reliability and maintainability improvements for O&S Costs reduction. Finally, modularity is absolutely essential for Horizontal Technology Insertion (HTI) and Modernization Through Spares (MTS). The first cousin of modularity is accessibility. Even though the item may be modular, if the item is not easily accessible to the maintainer at the prescribed level of maintenance, the ability to capitalize on the benefits of modularity is severely diminished. Line Replacement Units (LRUs) must be

designed whereby they are easily accessible without the use of special tools, procedures, or any other uncharacteristic maintenance practice.

c. Testability

One of the principal root causes for a supply chain filled with good parts, that are believed to be bad, is testability. Five of the 12 systems studied specifically noted major testability improvement programs. A recurring problem in maintainability design is failing to design the item for proper testability at the proper level of maintenance. Ineffective built-in test, poor diagnostics, inadequate fault isolation, and a variety of other testability problems result in a bulging supply chain of unnecessary repairs. Furthermore, test equipment and software-intensive test program sets are constantly changing and tend to provoke a testability environment of chaos. The feedback loop from the support system to the materiel developer is constantly filled with technical testability problems, suggested engineering changes, and clarifications over procedural issues. In many cases, the fundamental problem is improper or dysfunctional test equipment.

D. PLANNING ROLES

1. Focus on Maintenance Planning, not Supply Support

Contrary to the apparent belief system of the Service's "materiel" commands, maintenance (not supply) is the backbone of the support system. The research shows that logistics efficiency and effectiveness flow from a maintenance plan. Yet a tremendous degree of effort is being invested in maintaining visibility of parts, accelerating their movement, shrinking supply footprints, and reducing their procurement times. The culture seems to suggest that "if we throw enough parts at our logistics problems we're bound to solve the problem sooner or later." In reality, the cancer that eats away at the body of most of the support systems that were studied is the poorly-constructed maintenance plan. Four of the studied fielded systems indicated problems with the basic maintenance plan. Sadly, many fielded systems are still discussing "maintenance concepts" which is simply an indication that a developmental intention has never matured into an actual reality. Others are "modifying maintenance concepts" as an admission that the previously-conceived plan was wrong and inoperable. Constant shifting of the

maintenance levels (i.e., organizational, direct, intermediate, depot) for replacing and repairing of maintenance-significant items are very common. This instability results in unnecessary expenditures due to constantly changing the multitude of affected resources (e.g., publications, training, parts, stockage levels). Aside from the various design activities discussed in previous paragraphs, the key "planning" activity of the logistics community is to properly structure a coherent, stable, and executable maintenance plan for the system. However, the importance of maintenance planning (as opposed to supply support) varies by weapon system. Systems with simplistic maintenance concepts (e.g., exchange of LRUs only) should place significantly more importance on the design and execution of the supply system. Examples of six specific maintenance deficiencies noted in the research materiel are the following:

a. Un-testable Items

To identify the need for repair, the correct condition of the item must be clearly defined. The root cause of most of the No Evidence Of Failure (NEOF) population of parts in the supply system is a dysfunctional test and failure-identification system. BIT-effectiveness must be excellent and comprehensive. Often, many BIT-effectiveness measurement techniques ignore certain populations of failure modes (e.g., wring connection). In other instances, a high BIT-effectiveness rating may disguise many failures because they are not even tested, are not considered in the effectiveness calculation, and therefore can give a false and very misleading impression of the testability of the over-all system. Finally, defect criteria for mechanical devices (which are not BIT-testable) must be unambiguous. The Chief Logistician should always ask the contractor to quantify all failure modes that are not testable, qualify their effort and criticality to the system, and define what techniques will be employed to mitigate their impact to system performance.

b. Misallocated Levels of Maintenance

The maintenance is performed at the wrong level. The requirements at a specified level must not exceed the skills of the maintainer. Furthermore, the complete portfolio of resources (tools, test equipment, facilities, etc) must be reasonably and practicably available. Often, the materiel developer and contractor's analysis fail to

properly assess the realities of the military's maintenance environment and fields a maintenance plan that is not executable. In particular, there must be adequate time for the maintainer to devote the necessary effort to the maintenance requirements.

c. Inadequate Maintenance Training

A few instances were noted in researching the specific O&S initiatives of weapon systems in which poor maintenance training appeared to be the root cause. Excessive preventive maintenance tasks are inherently a tactical procedural mistake and a strategic doctrinal mistake. Unnecessary maintenance, although motivated by important reliability-centered maintenance doctrine, only creates expenditures in the area most susceptible to O&S Costs increases: military personnel. Since military pay constitutes the highest percentage of O&S Costs, seemingly minor increases in task requirements results in exponential increases of military pay cost when multiplied by hundreds of systems and people. Finally, the research suggests that the related issue of "skills" is also a significant problem. Often, the Military Occupational Specialty (MOS) does not provide individuals with the sufficient knowledge, skills, and abilities to execute the planned tasks.

d. Inadequate Maintenance Procedures

Closely allied with poor training is poor maintenance procedures. With poor procedures, improper troubleshooting is common and "good" items are coded as unserviceable. Additionally, operator-induced failures are common because of deficiencies in procedural narratives. Furthermore, the advent of electronic procedures, via Integrated Electronic Technical Manuals (IETMs), have resulted in both major improvements and new headaches. Drawings, schematics, and other data are more difficult to read electronically versus hardcopy. The normal human preferences with using and following a hardcopy are difficult to overcome. To be a true O&S Costs reduction measure, new state-of-the-art procedures must solve many more problems than they create.

e. Underachievement of Maintenance Times

A common problem seems to be a pattern of exceeding the planned mean-times-to-repair, the mean time to troubleshoot & test, and other maintenance time

measures. If patterns of excessive time persist, the military simply improvises with shortcuts and workarounds, which circumvent the maintenance, plan and ultimately lead to excessive O&S Cost growth. Next-higher-assemblies, containing good sister subassemblies, are turned-in for repair. Demands for readiness during extended maintenance times drives the local unit to stocking excessive parts, resorting to cannibalization, implementing extensive "controlled substitution," and re-allocating additional personnel to these burdensome maintenance requirements at the expense of other areas. Strategically, the reduced confidence in the maintenance plan and the resulting preventive and corrective measures generate an irreversible growth in the logistics tail of the system.

f. Attention to Maintenance – Significant Items

An obvious trend in the data is for a few items to represent the majority of O&S Costs. In two systems studied, a single item was 20% to 30% of the total O&S hardware cost for the entire system! Furthermore, as few as a dozen items may represent 60% to 80% of the total parts costs. Strategic R-TOC efforts must focus on these and other cost drivers as the critical maintenance items. After reliability efforts on these items have minimized their demand for maintenance, the insightful maintenance planners should spend the majority of their time on these handfuls of items. Design characteristics of modularity, accessibility, and testability must be absolutely validated. Resources to execute maintenance at the prescribed level must be defined and proven. Sensitivity analysis must be conducted at all levels with realistic assumptions of what could (and will) go wrong with the maintenance plan and how resilient the maintenance plan is to the inability to achieve skill levels, testability goals, time requirements, and a host of other factors.

2. Right "Fit" into Service's Logistics Systems

Somewhat independent of weapons system ownership cost reduction efforts are a wide variety of O&S initiatives that are general in nature and apply to multiple systems and commodities. Initiatives such as Focused Logistics, Wholesale Logistics Modernization, Lean Logistics, and Total Asset Visibility have excellent prospects for substantial savings within the Service provided the various program office's insure their

systems and support plans are designed and constructed to be compatible with the requirements of these generalized initiatives. However, the proponents for these two categories of efforts are in two entirely separate chains of command. The weapon system-specific initiatives are being led by the various project managers in the Program Executive Office (PEO) chain while the general initiatives are being led the three Service's materiel and logistics commands. Consequently, to exploit the full potential of these similar efforts, the two camps must completely coordinate and cooperate with each other. Currently, this cooperation appears to be only voluntary and motivated by a common desire to collectively reduce ownership costs. However, since there are few actual requirements to make similar efforts compatible with each other, the prospects of sub-optimizing the general and system-specific cost reductions efforts appear to be highly likely. To bridge this gap, the Chief Logistician must fully understand the general initiative and then export these needs into the design and plans of his specific system. When there are additional costs to change the specific system to adapt to a general initiative of one of the Services, the Chief Logistician must ensure the requirement is clearly identified, the resources quantified, and the decision-maker is equipped with the information to make an informed decision. The funding responsibility should be shared by both parties since it provides mutual benefit. Finally, there is often a dichotomy between the acquisition policies of the various Services and statutory requirements (e.g., Prime Vendor Support vs. Break-out Contracting/Small Disadvantaged Business). The Chief Logistician must strike a delicate balance between these very important constraints.

3. Selecting the Correct Contractor Logistics Support

Possibly the most common initiative being pursued across the Services and various programs is some form of contractor responsibility for a large segment of the support system. All twelve systems studied indicated some form of contractor logistics support and four of the systems are either using or considering system-wide contractor support. The leadership directives and revised acquisition policies are littered with the buzz words of Prime Vendor Support, Total System Performance Responsibility, Fleet Management, and Contractor Logistics Support. All point to the same conclusion: contractors should have a major role in supporting the systems they produce. The

wisdom of this strategic shift remains mixed. Advocates tend to be Project Managers who see contractors as possessing the innovation to revolutionize a hopelessly bureaucratic and inefficient organic support system. Detractors tend be the Service materiel and logistics commands who see the organic system as equally capable of innovation and are very suspicious of the possibility of greater contractor cost over the long-term due to sole-source arrangements. While the advent of performance specifications is essentially forcing contractor support in many instances, the Chief Logistician must remain an honest broker in this evolving food-fight and consider all factors in making his life-cycle support recommendations to the Project Manager. While the existing literature on this subject has excellent rules on considering contractor support, the following analytical ideas are presented which directly relate to the decisions made in the strategic reduction of O&S Costs.

a. Enter into Contractor Support by Choice, not by Default

Within many program offices, it appears that contractor support is being pursued by default rather than by choice. For example, while performance specifications for new systems makes development of organic support difficult, they do not make it impossible or even improbable. The existing bureaucratic nature of the organic infrastructure and methodologies makes innovation challenging; it does not make it impractical. Entering into contractor support should be a conscious choice made from an objective analysis of the facts, not as an excuse to avoid difficulties and frustrations of a naturally-bureaucratic organic philosophy.

b. "New Starts" are where Contractor Support is Most Easily Executable

Converting fielded systems to contractor support is costly, time-consuming, resource-draining, and politically-challenging. The total return on investment is usually not worth the trouble. Cost comparisons considering the conversion usually ignore the previous investments into organic support that are essentially wasted when organic support is abandoned for contractor support. Furthermore, the net impact on the total Service can be devastating (e.g., Apache Prime Vendor Support to Army's Working Capital Fund). However, conversions of sub-

systems and LRUs (instead of the total system) in fielded systems are many times very executable.

c. Label Contractor Support for What it Really Is

The buzz words flying around for the various fads on contractor support are usually misleading. Prime vendor is not one source but usually a consortium of contractors and subcontractors/vendors. Fleet is not really fleet-wide management nor does a contractor really have “total system performance responsibility.” Contractor support proposals should objectively define what they’re attempting to accomplish. Correctly labeling contractor support provides clarity of purpose, avoids needless arguments over implications and hidden agendas, and conserves resources over unnecessary debates and studies.

d. Apply Contractor Support by Maintenance Level

The support system revolves around the maintenance plan. Consequently, contractor support should be applied based on the maintenance plan as allocated to the maintenance level. The vast majority of contractor support activities are depot-level in nature. The test equipment, facilities, skills, and procedures for depot-level repair at organic facilities are essentially the same as exists on the contractor’s production line. Consequently, the chief enabler of support (the maintenance plan) is very easily established at contractor’s facilities as compared to organic depots. Once the maintenance capability is established, the other logistics elements (e.g., supply, transportation, training) easily follow suit. A key point to remember is that depot-level denotes a complexity of support, not the geographic location of that support. Depot-level capabilities can exist at all geographic levels of support from theatre to the individual unit. Many times, the most effective contractor involvement is depot-level support for maintenance-significant items tied to readiness needs that can be accomplished by a few highly-skilled technicians in forward-deployed areas. Conversely, contractor support becomes far more complicated to execute once you leave the conventional wholesale support structure and move forward in the general, direct, and organizational maintenance levels of the retail environment. Logisticians should use great caution in developing contractor support in these retail environments.

e. Maintain the Proper Business Perspective

Many contractor initiatives today provide the impression is that all the Government needs is a small project office to “over-see” the program, a contracting officer to write a check, and the contractor to take care of the rest. The logisticians designing any contractor support approach should be very cautious of the business position that a profit-motivated contractor can establish in a sole-source arrangement for the system lifetime. The contractor guys were not asleep during their basic acquisition class when the chart showed 60% to 80% of the total life-cycle costs are in the O&S phase. This new-found business opportunity holds enormous profit potential for the innovative contractor. “Buying-in” to a program with reduced development and production profitability in exchange for the mother-lode of operation and support profitability can become common. Buyer beware!

f. Control the Execution of Contractor Support

To mitigate the business risk of sole-source life-cycle contractor support, the Government should strongly consider mechanisms to control the contractor support. The most common method is the GOCO approach: Government-Owned Contractor-Operated. The Government owns some or all of the capabilities and the contractor provide the manpower and skills. In essence, the contractor provides the "brains" and the Government provides the "brawn." Not only does this approach mitigate risk but the approach may also significantly reduce cost. For example, the Government may provide the depot-level facilities at no cost and the contractor can substantially reduce his overhead rates of expensive in-plant charges. Test equipment, tooling, and fixturing can be procured by the Government and furnished to the contractor who operates and maintains the equipment. Regardless of the approach taken in a particular system, the net effect should be to mitigate risk and reduce cost.

g. Measure and Incentivize Performance

The contractor’s performance must be measured by criteria that are directly applicable to the specific type of contractor support. One shoe does not fit all. Logisticians must take care to tailor metrics to the exact result that needs to be measured and incentivized. Furthermore, the metric needs to be clearly within the contractor’s

scope of responsibility and authority. Many contractor support arrangements are attempting to contract for such metrics as readiness and stock availability, which directly and indirectly depend on Government/military organizations and activities.

h. Performance-Based vs. Traditional Support

The advent of performance specifications have driven PMs to buy an outcome-based, performance-driven support from prime contractors. This approach is the antithesis of the traditional multi-contractor organic support structure developed over numerous years under the MIL-STD-1388 "Logistics Support Analysis" process. This strategic disconnect results in many PMs planning a support structure that is totally reliant upon a single prime contractor, often under a sole-source long-term contracting agreement. This prime-exclusive support arrangement carries the possibility of significant cost growth, a single methodology of support, a single mindset for innovation, and a multitude of other risky behaviors inherent with placing all of your marbles in one basket.

4. Develop a Business-based Support System

From an over-all review of the ongoing design and planning activities for O&S Costs reduction, one common theme emerges that is often overlooked by logisticians in designing the system and planning the support structure. The missing theme is the need for a support system that compliments the business-based realities of the how the military operates today. Under the new working capital funds, the basic business responsibility for the management of parts has been shifted from the materiel developer to the local military commander. Now, the military must make smart business decisions in a world of limited financial resources with almost unlimited alternatives. Over-all readiness becomes an affordability issue. The decisions to perform maintenance and order parts becomes a trade-off of perceived return on investment. Needed maintenance, but with a low return on investment, is often postponed or cancelled. Cannibalization and controlled substitution of parts is rampant. Unauthorized maintenance is often accomplished by guess work and trial-and-error in attempts to perform depot-level repairs in an organizational or direct support environment. Available funding is often diverted to pay for critical base operation support bills. All of these activities are

motivated by the inevitable challenges of managing a financially-based business. Logisticians must understand that the winds of change have been completely reversed. For the fielded systems today, their logistics systems were constructed against the backdrop of a "free issue" parts system. Since parts were free, the military requirements drove maintenance away from the front lines and back toward depot-level. Maintainable items were consolidated in extremely-extensive "black box" LRUs and simply evacuated to general or depot support facilities for repair. Units stocked large quantities of free parts at the organizational and direct support levels to maintain readiness through virtual unlimited supply. Expectantly, abuses were common. In reaction, the defense department has indirectly given the military the procurement responsibility for parts through the working capital funds. Since the military must now pay for the parts (instead of being "free"), the "winds of maintenance needs" have completely reversed themselves. Now, maintenance has been driven forward. The military needs a maintenance design that focuses on the lowest-cost part that can be exchanged at the farthest point forward. For example, the $2,000 circuit card that was once exchanged at general support or depot-level is now needed to be replaced at organizational or direct support. The accompanying logistics tail for this seemingly-simple move is staggering. The maintainable design characteristics of the hardware must be changed. Greatly improved test equipment is needed, more detailed procedures must be developed, and smarter solders must be trained. In summary, the architects of future logistics systems must use this business-based reality as an underlying theme of all proposed design and planning activities for the reduction in ownership cost for this type of logistics system. Under "operationalizing acquisition" initiatives, the role of the military in business affairs will almost certainly increase in responsibility and authority.

5. Correctly Select Commercial Items

While commercially-available, non-developmental items have always been a preferred acquisition approach, their role in reducing O&S Costs remains suspect. For every success story, there are numerous logistical headaches. Proprietary data usually precludes the establishment of a Government-performed or controlled support system. Cost growth from a sole source of repair is common. Constant changes, fueled by a

private-sector motivation to chase the state-of-the-art, generates continuous logistical changes. While performance specifications have mandated the use of commercial items in many circumstances, the logistician must use both scientific and artistic analyses in determining whether or not commercial items are the most conducive to the strategic reduction of ownership costs. Many times, the long-term consequences of the loss of Government control are difficult to quantify. Unfortunately, since the degree of commercialization is usually pre-determined at source selection, the logisticians must define these advantages and disadvantages extremely early in the acquisition process.

E. INHIBITORS

1. Overview

The research indicates a wide variety of factors that inhibit the Project Manager and Chief Logistician from reducing O&S Costs. The impact of each inhibitor tends to vary by the current state in the system's life-cycle. New-start and development systems have much wider latitude with changes, since they do have established O&S funds, operating relationships, structural mechanisms, and other factors.

2. Specific Inhibitors

The following eight major inhibitors were noted in the research data. For each inhibitor, the principal problem is described and an analysis of suggested actions is presented.

a. Clear Definition of PM's Role

Problem: The PM's specific role remains unclear. Is the PM's total life-cycle role a "management" or "cost" responsibility? Some policy memorandums define the PM’s responsibility as a life-cycle management responsibility while others focus on simply a cost reduction responsibility. Additionally, how can the PM be responsible for costs, particularly in the sustainment phase of the life-cycle, for which the PM has limited ability to manage or control.

Analysis: A distinction should be made between “manage” and “influence.” The PM's role should be to a) manage those costs that can be identified and controlled within the PMs assigned responsibility and authority and b) influence those costs outside of the PMs assigned responsibility and authority. Specifically, the PM

should be held accountable for those R-TOC costs for which the PM can reasonably manage. These "manageable" costs should be included in the key program management documentation and should be measured at milestone reviews. Manageable costs could include activities currently managed by the Services' major subordinate commands (e.g., depot maintenance). However, the PM should still be held accountable for R-TOC, which can be "influenced" by PM managerial decisions. For example, the PM can "manage" the cost of achieving a Mean Time Between Failure (MTBF) rating for a piece of developmental hardware which directly "influences" the extent of Military Personnel costs required to support varying degrees of labor given different MTBF. Key "influential" R-TOC factors and criteria should be included in the PM's metrics and should quantify the estimated impact to system-specific O&S Costs for which the PM can only "influence."

b. PM Control Of System-Specific O&S Funding

Problem: The lack of PM control of system-specific O&S funding is probably the greatest single inhibitor to R-TOC. Until the PM has the responsibility and authority for system-specific O&S funding, the desired effect of optimizing system performance while minimizing the cost of ownership through a life-cycle management approach cannot be realized.

Analysis: The leadership must a) identify the System-Specific O&S Costs Elements to be managed by PMs by weapon system, b) develop a cost accounting structure for O&S funding that allows planning, programming, budgeting, and execution by weapon system to include flexibility for reprogramming of funds and c) develop the specific processes and procedures to manage O&S funding by weapon system. Examples of system-specific O&S funding that could be managed by the PM are depot maintenance, second destination transportation, and supply depot operations.

c. Lack Of Good O&S Costs Estimating Models

Problem: The lack of good O&S Costs estimating models, with accompanying methodology, precludes effective implementation of R-TOC. Specific problems include a) the inability to validate the input data b) the inability to crosswalk "estimating" cost elements to "actual" cost elements c) the inability to differentiate

between system-specific costs and common, non-system-specific costs (to include end-item application) and d) the lack of confidence in a forecasting model upon which to baseline and measure O&S Costs. In particular, a validated model is needed for including projected O&S metrics in milestone exit criteria for developmental systems.

Analysis: The DOD leadership must task the appropriate organizations to develop and validate an O&S Costs Estimating Model & Methodology for "Weapon Systems" which will include the appropriate elements of existing cost estimating databases within the Services. The model should specifically remedy the fundamental problems listed above.

d. Lack Of Sufficient Investment

Problem: Monumental R-TOC reduction requires substantial investment funding. Numerous systems in the research complain of insufficient investment funding to include the inability to retain savings when R-TOC initiatives are successfully implemented. This study clearly indicates that the majority of sustainment costs are "predetermined" by developmental and producibility decisions. Since the majority of our systems are already in the sustainment phase of the life-cycle, the PMs have limited ability to radically reduce TOC because of limited investment funding to implement key materiel modifications and support structure changes.

Analysis: The leadership should identify and "fence" additional sources of investment funding for the top O&S Costs drivers. Specific criteria (e.g., return on investment, priorities, needs) should be published for obtaining the funds. Additionally, for developmental systems, the leadership should identify additional $RDTE to invest in high-payoff opportunities to include those high-potential savings initiatives in which specific returns on investment have yet to be identified. Long term, the leadership should consolidate all types of "investment" funding for TOC reduction into a single "pot" and stop the proliferation of numerous categories of specialized funding with highly-restrictive qualification requirements.

e. Lack Of Specific Guidance On Reducing Military Pay Costs

Problem: For many weapon systems, military pay is the largest category of O&S Costs. However, there is little or no emphasis on reducing these costs given the

perception that the leadership is not interested in reducing force structure. Consequently, a variety of options of reducing O&S Costs are not being pursued even though they offer sizeable savings...but in the wrong categories.

Analysis: The leadership should publish specific guidance pertaining to O&S initiatives, which reduce manpower requirements, which do not adversely-impact force structure levels (e.g., allow re-allocation of manpower to other requirements). This area appears to be the “mother lode” of potential R-TOC, but is not being aggressively pursued by many systems.

f. One-Year $OMA Funding

Problem: The one-year nature of $OMA encourages unnecessary spending (i.e. use or lose spending) and precludes a variety of managerial options which are only executable with multi-year funds.

Analysis: The leadership should develop a recommendation to Congress (with supporting rationale) that $OMA be changed to two or three-year money to give PM’s and Services maximum flexibility is using O&S funds. Additionally, this change should also include reprogramming authority.

g. Reprogramming Of O&S Funds Into $RDTE And $PROC Accounts

Problem: One of the ultimate goal of R-TOC...modernizing Army systems with O&S savings...cannot be fully realized until a clear bridge is developed by which O&S savings cannot be reprogrammed into the appropriate $RDTE and $PROC accounts. In particular, a specific PM needs to be "rewarded" for O&S savings by allowing the funds to be reprogrammed for modernization initiatives for his/her particular system or product line.

Analysis: The leadership should develop an additional POM process by which O&S savings are directly reprogrammed into $RDTE and $APROC accounts and fenced for modernization initiatives for specific weapon systems.

h. Depot Maintenance Restrictions

Problem: Current law limits the amount of depot maintenance, which can be contracted to 50%. Since depot maintenance is one of the largest categories of O&S

system-specific funds, which could be controlled by the PMs, this restriction prohibits innovative opportunities for contractor depot maintenance.

Analysis: The DOD leadership should lobby Congress to remove the 50-50 Depot Rule and state the need to maintain a mobilization-required organic infrastructure based on true national security needs, not an arbitrary 50-50 split.

F. CHANGES TO THE CHIEF LOGISTICIAN'S STATUS

1. Overview

The research data suggests that in order to strategically reduce O&S Costs, the Chief Logistician must become somewhat of a superman of acquisition logistics. The range and depths of the person’s expertise to address all of the roles listed in this analysis is certainly a formidable challenge. To accomplish this goal, the analysis suggests the following changes listed below.

2. Knowledge & Ability

To reduce future O&S Costs during development programs, the research data indicates that the Chief Logistician should have a strong technical background. Thorough experience in maintainability engineering and maintenance planning is required. An engineering background (experience and/or education) is highly desired. To be an impact player with the dominating Chief Engineer and other key PMO leaders who are primarily experienced & degreed engineers, the Chief Logistician must have technical expertise to debate, negotiate, and resolve key program decisions related to logistics. Credibility is as important as capability.

3. Availability

A source or pool of qualified Chief Logisticians and key superbly-trained logisticians must be available to provide the talent at the right time. Preferably, a new-start systems type of office should provide an institutional base from which to rotate this specialized form of logistician in-and-out of these relatively short-term assignments.

4. Position

The research indicates that the Chief Logistician lacks the proper position for achieving the desired results. As the "Rodney Dangerfield" of the Acquisition Corps, the logistician is often just a salmon swimming up-stream to be eaten by the bears. The

Chief Logistician has a lower status, lower grade and lower organization position compared to his counterparts in a typical project office. These positional inhibitors must be resolved as a prerequisite to strategic change in R-TOC.

V. CONCLUSIONS

A. SUMMARY

The Chief Logistician has a variety of strategic imperatives and key roles in order to reduce future O&S Costs. These imperatives and roles all occur prior to the system's Critical Design Review (CDR) and "predestine" O&S Costs long before they actually occur. A mere knowledge of general acquisition - logistics information is insufficient when attempting to reduce future O&S Costs during the development phase. History proves this insufficiency. To effectively fulfill these strategic imperatives and key roles, the Chief Logistician must fully understand their implications to the design of the weapon system and planning of the logistics support structure. Finally, the Chief Logistician must recognize the numerous inhibitors to fulfilling these responsibilities as well as his difficult occupational position in the typical project office.

B. STRATEGIC IMPERATIVES (Secondary Research Question #1)

"Prior to the CDR, what are the specific strategic imperatives for significant reductions in O&S Costs?"

Answer: The Chief Logistician must understand the criticality of timing and the "Law of Predestination of O&S Costs." Any time after the concept phase is too late. The involvement must be as a participant and not as a spectator or consultant. The person must develop realistic expectations of O&S Costs reduction possibilities and implement specific plans for overcoming the Law of Predestination. The Chief Logistician must recognize that all strategic choices, conscious or otherwise, have major consequences. In particular, the person must ensure that adequate logistics weight is assigned to logistics in the source selection process.

C. KEY DESIGN ROLES (Secondary Research Question #2)

"Prior to the CDR, what are the key "design" activities of the Chief Logistician required to reduce future O&S Costs?"

Answer: The Chief Logistician must ensure his staff is actively engaged as logistics engineers in the systems engineering process. The logistics engineers must be in a role of defining logistics requirements rather than just influencing the design. The Chief Logistician must understand that defining support requirements is the single most

important role and must ensure that they are sufficient, measurable, defendable, and critical to logistics success. The person must maximize the reliability and maintainability characteristics of the system. In particular, the maintainability design must have an open-system architecture, be highly modular and accessible, and have excellent testability characteristics.

D. KEY PLANNING ROLES (Secondary Research Question #3)

“Prior to the CDR, what are the key "planning" activities of the Chief Logistician required reducing future O&S Costs?

Answer: The Chief Logistician must focus on maintenance planning as the backbone of the support system, not on supply support. In particular, the logistician must look for key deficiencies in the maintenance plan such as untestable items, misallocated levels of maintenance, inadequate maintenance training and procedures, underachievement of maintenance times, and lack of attention to maintenance-significant items. The Chief Logistician must ensure his system is compatible with on-going Service-directed O&S reduction initiatives. The selection of the correct type of Contractor Logistics Support (CLS) is critical and should be entered by choice not by default. CLS should especially be considered on all “new-starts,” labeled and implemented for it’s true intent, and applied by maintenance level based on the maintenance concept. Additionally, the CLS must maintain the proper business perspective, be appropriate measured with performance incentives, and should utilize Government furnished equipment & facilities where appropriate to mitigate risks and reduce costs. Finally, the key planning roles include a support system that is based on the new business realities of the working capital funds as well as the correct selection of commercial items.

E. INHIBITORS (Secondary Research Question #4)

“What are the principal inhibitors that constrain the Chief Logistician in reducing O&S Costs?”

Answer: The Chief Logistician faces a comprehensive field of landmines that inhibit long-term O&S Costs reduction. The person’s boss, the Project Manager (PM), has an unclear role in R-TOC, hampered by large responsibilities with limited authorities.

The PM does not have control of any O&S funding, has marginal O&S Costs estimating models, and insufficient investment funding. Furthermore, there is minimal specific guidance on reducing military pay costs, the single largest O&S Cost category. Finally, the restrictions on the usability of $OMA funding (one-year only), the inability to reprogram O&S funds to modernization accounts, and the congressional restrictions on depot maintenance workloading are highly-complex inhibitors to overcome.

F. CHIEF LOGISTICIAN'S STATUS (Secondary Research Question #5)

"What changes can be made to the Chief Logistician's status during developmental programs to enable that person to more effectively reduce future O&S Costs?"

Answer: Based on the requirements outlined in this research, the Chief Logistician must be an immensely talented individual with unique acquisition logistics experience. The typical Chief Logistician must have unique knowledge and abilities in the maintainability engineering and maintenance planning specialties. Changing the Chief Logistics occupational status to a technical position during the developmental period is highly desired. The Chief Logistician needs a ready pool of supporting logisticians with the unique skills required for front-end logistics engineering. The Chief Logistician's position in the program office must have equal stature with all other leaders.

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